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Do the Simple Things First

AT THE recent meeting of the Practical Refrigerating Engineers, Victor Azbe remarked that "many an engineer is walking around with a dream in his head that would cost thousands of dollars to execute, while conditions exist which are causing waste and could be easily corrected."

It is easy for the man who has to run it to see how a plant could have been better designed.

Perhaps the conditions that it was designed to meet have changed or failed to develop. Perhaps it was designed before the apparatus now best adapted to its purposes was available. Perhaps, and most likely, it was never designed at all, but is the result of the collective representations and persuasions of various salesmen, often after considerable intervals, a piece here and a piece there as the business and the demand upon the power department grew.

It would be nice to wipe the slate clean and put in an up-to-date plant with apparatus that the engineer knows would pay for itself out of the savings that it would make.

It is exasperating for an engineer who knows that he is burning a lot more coal than he needs to, under boilers set in the old way and perhaps for a type or grade of fuel no longer available; and he is likely to be discouraged and disgruntled if his suggestion that they be raised and reset in accordance with newer and better practice is not adopted.

But what has he done to prove to the boss that he knows what he is talking about?

Has he done the best that can be done with what he has to work with? And has he made the boss know it and why he cannot do any better?

Is he sure that he is firing the now-available fuel in the best possible way and not trying to use it too nearly as he was accustomed to using the other? Is that old setting as tight as it should be in places where air should not get in? Are the boilers clean of scale and of soot? Is the feed water as hot as it could be? Are there leaks that could be stopped, drips that could be trapped and saved, exhaust steam that could be utilized, pipe and other heat-radiating surfaces that could be covered, walls and arches and baffles that could be patched and made to last? Are the valves of his engines set correctly, and if he has several are they cut in and out so as to handle the load most efficiently? Are his pumps and heaters and such auxiliary apparatus and appliances as he may have, kept in the pink of condition?

There are myriads of things that can be done about an ordinary steam plant, without any expenditure beyond a little thought and labor and some inexpensive material, that will collectively make a big difference in its record. The boss likes to see these things done and likes to know about them and their effect. He likes to see his engineer interested in keeping the plant up and getting the best out of it.

And when a man has demonstrated that he can do things with what he has, he will have no difficulty in getting more and better.

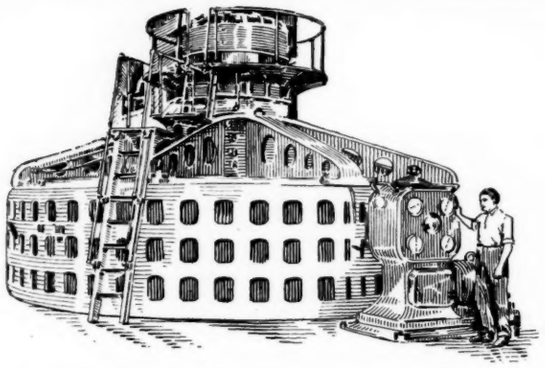
As the good book says, "Thou hast been faithful over a few things, I will make thee ruler over many."

F. R. Low

Operating Instructions for Hydro-Electric Stations

by

Ralph Brown *



Writing of Operating Instructions—Methods of Operation—Putting the Main Units on the System—On Hand Control a 12,000-Kva. Unit Has Been Started and Paralleled With Other Machines in 45 Seconds

TO BE OF the greatest value, operating instructions should be prepared with the cooperation of the operating men who will be required to use them. It will usually be found that various sections can be written by the operators, and if this method is followed, there can be little feeling among them that some new and untried system is being developed to destroy initiative or prevent any individual from showing ability.

Considering those hydro-electric stations that have been in operation for some time, members of the operating force should be invited to put in writing the methods to be followed and precautions to be observed to insure the best results in carrying out those operations with which they are most familiar. Naturally, men concerned with electrical operation are best able to write on that subject, while those concerned with hydraulic operation can best write instructions to apply to this important matter.

The instructions written by members of the operating force should be incorporated with those prepared by the chief operator or superintendent, and the completed instructions should accord with those methods which tests, data obtained from manufacturers, practices followed in well-operated stations, and experience indicate to be the best; and a high standard of grammatical construction should be kept in mind. Each paragraph should be lettered or numbered, and the usefulness of the instructions will be greatly increased if fully indexed.

Operating instructions should be divided into two major sections, one dealing with routine, day-by-day operation, termed "Normal Operation," and the other, which covers unusual operation, such as handling trouble, and operation under unusual circumstances, in so far as they may be anticipated, known as "Abnormal Operation." These two sections should be subdivided into sections covering "Normal Electrical Operation," "Abnormal Electrical Operation," "Normal Hydraulic Operation" and "Abnormal Hydraulic Operation," and should be bound in a screw-post loose-leaf binder. These instructions, together with others covering routine cleaning and inspection of equipment, the methods to be followed to insure the safety of workmen, maintenance of equipment and general station rules, from what are known as "Permanent Instructions." These sections cannot be covered in this article, but it should be noted that the instructions covering the cleaning and inspection of apparatus form a very important section, for the usefulness of operating instructions will be greatly lessened unless the equipment to which they apply is kept in first-class condition, and regular, careful inspection followed up by any necessary repair work, is the only method known which will insure equipment being kept in this condition.

In another loose-leaf binder is contained memorandums, notices, or bulletins issued from time to time termed "Current Instructions" pertaining to operation, or instructions supplementary to those applying to "Normal" or "Abnormal" operation. To insure that instructions will be kept strictly up to date, any change made in equipment which may affect operation is noted in a copy book at the completion of the work, and the original copy at once issued to the operating men concerned. A bulletin or notice follows, which is placed in the "Current Instructions" binder, and at intervals of 60 days supplementary instructions of a permanent nature are incorporated with those in the "Permanent Instructions" binder. Letter-size sheets (8½x11 in.) of durable typewriter paper are used in the binders. Instructions are generally typewritten, thereby making it more convenient to correct and modify them, but in some stations printed sheets are used. Several copies of instructions will be required in order that they shall be readily accessible to all concerned.

In order to make all instructions as clear as possible, drawings should be freely used. Usually, existing drawings reduced to letter size and reproduced by photostat will be suitable, but special drawings may be required. Curves, especially those showing storage capacity, river discharge and turbine discharge rates, will also be required.

Under the title of "Duties" forming a section included under "Normal Operation," should be clearly defined the duties of each operating attendant, so that no misunderstanding can ever exist as to the work any individual is responsible for.

Only when dealing with new apparatus of unusual characteristics or apparatus required for a special pur-

*The Great Western Power Company.

pose, should its description or purpose be included in the operating instructions. Such matter should appear in the "Current Instructions" binder, in the form of a bulletin, and it is well, owing to the monotony of operation in many stations, frequently to issue bulletins describing station apparatus and equipment, such as relays, lightning arresters, switches, pumps, governors, etc., or giving the results of tests relating to station equipment, thereby refreshing the memories and broadening the outlook of those concerned with operation.

It will be found that where the preparation of operating instructions is undertaken, an interesting field will develop as different methods of obtaining indentical results are discussed, and careful thought will frequently be required to select the methods to be followed. In fact, tests must sometimes be conducted to determine the best methods, and decisions should be based on three principal factors—safety of men, safety of equipment, and time required.

For example, considering one subject that should appear under "Normal Operation," in one plant generating units are always started and paralleled, while on hand control, in periods varying from 20 to 90 sec. between the giving of the "Start" signal and synchronizing the generator. In other words, 12,000-kva. low-speed generators are brought from rest, paralleled and loaded to capacity, if necessary, in an average time of 45 sec. This method is safe to men and equipment and fast, but a reliable signal system, dependable hand control, an accurate tachometer, and well trained operating men are positive requirements where such units are to be started in 45 seconds. In other stations units are started and synchronized on governor control in periods of from 2 to 8 min. with, say, an average of 3 min. Starting a unit on governor control has certain advantages, the principal one being that it is not necessary to change from hand to governor control. However, unless the governor control is of particularly poor design, in which event the fault should be remedied, a unit can generally be started and synchronized to the best advantage on hand control, and the changing from governor control to hand control and vice versa required when machines are stopped or started, makes the operating men so familiar with the procedure that no time is lost when the same operation is required during an emergency. While the writer favors starting units on hand control, the characteristics of a given plant and of the system of which it forms a part are determining factors; but if units are started on hand control, operating men should be able to start on governor control at any time without delay.

Where it is necessary to switch in or out long sections of high-voltage transmission lines, two methods are followed. One is to carry out such switching in practically the same manner as short, low-voltage lines are handled, and the other is to switch in or out such lines at low, or even zero voltage, by using a separate generator, if it is possible to do so. It must be decided, then, if the first method should always be followed, completely excluding the second, or if both methods should be used, depending on specific conditions and generating equipment available when switching must be done.

In switching ("cutting") transformers in or out it may be immaterial whether the low-tension oil switch is closed first or last, or it may be important that the high-tension oil switch always be closed last, when possible. The correct method should be determined, by test, if necessary, and specified in the operating instructions.

A generating unit can be made available for carrying load most quickly by bringing it to synchronous speed, paralleling by closing the oil switch, then closing the field switch. However, this method is hardly justified except where service requirements are unusually severe, because of the stresses to which the generators are subjected. In a station where such a method of self-synchronizing might be used to advantage, tests should be conducted, possibly with the aid of an oscillograph, to determine if it is safe enough to be included in operating instructions. Methods of paralleling generators on a dead bus are (A) to bring several units up to speed with their oil switches closed and no-load field current applied, or (B) with the units at normal speed, to close their field breakers simultaneously. Either of these methods may be used where a spare bus is available, or an entire station may be started in this way and synchronized with the system, instead of one machine at a time.

THE larger the station the greater is the value of operating instructions, but they can be applied with good results to plants of any size. Experience has indicated that practically all mistakes in operation can be attributed to ignorance and carelessness, and the occurrence of mistakes due to these two causes can be reduced to a greater extent by the use of written operating instructions than by any other method known to the writer. Briefly, the principal purpose of the instructions discussed herein is the training of operating men in the performance of their exacting duties, and for this important purpose there is hardly any substitute.

Operating instructions should clearly specify the limits for temperature and loading for all equipment, and a mark should be made with red ink on the scales of such instruments as ammeters, wattmeters and temperature indicators, at the figure indicating the limit; this will enable the equipment to be operated to the best advantage.

A point that should be emphasized is that all operations must always be carried out rapidly, so that fast, accurate operation will become a habit, for the ability to cope with an emergency requiring quick action can be acquired in no other manner. However, operation must never be carried out so rapidly that accuracy must be sacrificed or equipment abused.

Enough space should be devoted to each piece of apparatus and equipment to define clearly the method and sequence of operations to be followed under all imaginable conditions, and considerable space must generally be devoted, under the heading, "Normal Operation," to such subjects as voltage and frequency regulation, protective relays, the excitation system, and, where water must be conserved, to low-flow operation.

In one section should appear instructions covering all records and forms, and directions should be given for computing any value called for on any form, such

as the station log sheet. Some space should be given to illumination, and data, preferably based on a foot-candle meter survey, should indicate the location and rating of all lamps used in the station.

One of the most important factors relating to fast, accurate, and efficient operation is a reliable means of accurately transmitting signals to and from any number of operating men required to co-ordinate their efforts. Space does not permit of the further discussion of this important subject, except to say that it is difficult to conceive of a plant being operated to the best advantage without a dependable signal system of some description.

In the foregoing some matters relating principally to "Normal Electrical Operation" have been dealt with. In the section, "Abnormal Electrical Operation," such subjects as burnouts, fires, breakdowns, floods, failure of control voltage, generator runaways and transmission-line troubles must be considered, and instructions prepared for the guidance of the operating men in maintaining or, if interrupted, resuming service under these and other conditions differing from the ordinary. Too much study, involving careful consideration of the difficulties and unusual situations that have interfered with operation in other stations, and the lessons probably already learned in the plant for which instructions are being prepared, can hardly be devoted to the sections covering abnormal operation.

While some difficulties cannot be foreseen, the majority can be anticipated, hence the effort should be made to prepare suitable instructions before costly experience "inspires" their preparation. For example, if consideration is given to the effects of possible short-circuits, it may be found that sufficient current can be developed to damage the windings of power transformers, generators, of current transformers by distortion, or to open disconnectors. If so, the desirability of operating with a different system of connections, or of installing disconnector locks and reactance coils, is indicated before a disconnector is blown open, with possibly disastrous results.

The section entitled "Normal Hydraulic Operation" should comprise instructions applying to pumps, air compressors, the lubricating-oil system, relief valves, turbines, and any other equipment that the men concerned with hydraulic operation must operate or care for. Considerable space should be given to such matters as lubrication and cleaning of equipment.

A mimic hydraulic board, installed where it can be viewed by the switchboard operators, showing the governor piping layout, together with pumps, dummy valves and sump tanks, the pumps in service being indicated by signal lamps, will expedite operation. Other devices, the installation of which will generally prove profitable, are a large pressure gage connected to the governor system, placed in a central location, oil-flow meters in the supply lines to all important bearings and thermometers to indicate the temperatures of bearings. Since the ability of a hydro-electric station to render continuous service depends largely on the performance of the hydraulic equipment, such refinements as these are justified.

Under "Abnormal Hydraulic Operation" properly come the methods to be followed in the event of loss of governor pressure, failure of pumps or compressors, runaway generators, starting units for synchronizing by using headgates or penstock valves, or of the occurrence of other unusual situations.

Methods of Lubricating the Cylinders of Internal-Combustion Engines

By W. F. OSBORNE
Supervisor, Manufacturers' Service, Texas Company

THERE are various ways of getting the oil to the parts of an internal-combustion engine that require lubrication. The methods include direct feed from drip cups or manifold reservoirs, mechanical force-feed lubricators, inclosed-crankcase splash oiling, a combination of the crankcase and force-feed, and circulating pumps.

The drip cup is used principally for small gasoline and kerosene engines of the less expensive designs and supplies a sufficient amount of oil to the piston through suitable oil holes. In the horizontal type the oil is fed at the top of the cylinder far enough back so that the opening will never be directly exposed to the pressures within the cylinder. The oil flows down around the piston by gravity, and the reciprocating motion of the piston spreads it over the cylinder wall.

An oil for such an engine should be of medium viscosity and fed in the smallest quantities that will prevent wear. At least half of the lubricating oil goes into the cylinder, and if it is too viscous or not sufficiently volatile, it will cause carbon deposits. None of the oil is saved for re-use, and it is not necessary to use a grade especially refined for constant use in an engine of the crankcase-lubricated type.

The force-feed lubricator is frequently used for the lubrication of vertical cylinders and practically always for the better types of horizontal cylinders. The lubricator has the advantage that the quantity of oil fed can be closely regulated and can be delivered at just the right place for effective service. Engines so equipped can use one kind of oil for the cylinders and another kind for the bearings, in this way permitting the use of the viscosity best adapted for both conditions, which of course are quite different. The cylinders can be lubricated with a heavy-bodied oil if necessary, and the bearings with a light-viscosity oil. Some engines are equipped with a complete circulatory oiling system to handle the bearing oil.

The inclosed-crankcase method of lubricating bearings and cylinders is by far the most common system on vertical engines and, if the proper oil is selected, should give satisfactory results. Cylinders are lubricated by the splashing of the oil onto the lower part of the cylinder when the piston is in the upper portion of its stroke, and the motion of the piston gradually works the oil up into the cylinder. Other engines have a pump combined with the splash system to circulate the oil, and still others have every bearing lubricated

with oil under pressure from the pump, the cylinder getting sufficient quantity from the throwing of oil from the connecting-rod bearings.

Little trouble would be experienced with this method of lubrication if the oil could be maintained in its original condition, but this is sometimes very difficult if not impossible. In most engines there is some liquid fuel delivered to the cylinder, and this fuel is absorbed by the lubricating oil, lowering the viscosity of the latter and permitting the vapor to blow past the piston on the compression stroke. If the liquid fuel enters in some quantity, as might be the case when starting up a cold engine by priming, it will run down into the crankcase in a liquid state.

Effect of Dilution on Viscosity

The liquid fuel and the thin oil from the cylinder, no matter how they get into the crankcase, will reduce the viscosity of the entire quantity of oil. This is illustrated by Fig. 1, showing the variation in viscosity caused by an increase in the kerosene percentage. The thinned oil, which every engineer has seen and about which he has complained to the oil refiner, saying that "the oil thins down like water and is no good," is caused by the addition of the fuel, which is much lower in viscosity than the thinnest of lubricating oils. Gasoline is lower in viscosity even than water, and it requires only a small amount to thin the oil down seriously. A half pint of gasoline used to prime an engine will do the oil more damage than a month of running under normal conditions.

When an oil becomes reduced in viscosity, it fails to form a proper piston seal, more vapor leaks past, and the condition rapidly goes from bad to worse. Oil that

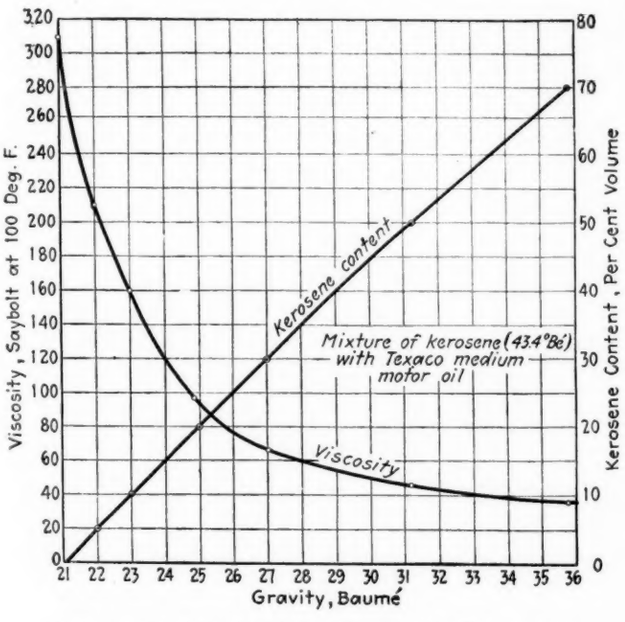

Viscosity, Saybolt at 100 Deg. F.
Kerosene Content, Per Cent Volume
Gravity, Baumé
Kerosene content
Mixture of kerosene (43.4°Bé) with Texaco medium motor oil
Viscosity

FIG. 1—KEROSENE CONTENT—VISCOSITY CHART

is too thin pumps past the rings into the combustion cylinder in larger quantities than can evaporate, spark plugs are fouled, ignition is affected, and the cylinder fails to fire. Fuel is wasted and a large portion of the unburned fuel goes down into the crankcase, aggravating a condition already bad. The engine loses "pep," starts poorly when cold, and may lose such a great proportion of its normal horsepower through decreased m.e.p. that it will no longer pull the load.

Many engines when in constant operation will absorb fuel into the crankcase oil, rapidly at first and then more slowly. A condition of equilibrium is finally reached at which the fuel is evaporated from the crank-

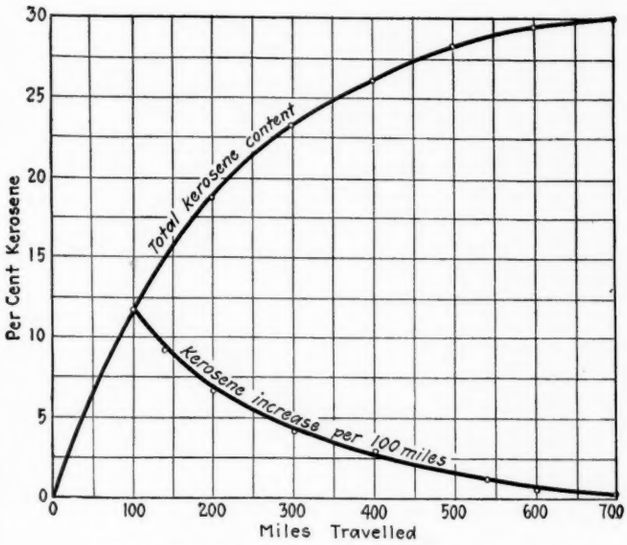


FIG. 2—INCREASE IN CRANKCASE DILUTION

case oil by reason of the temperature and agitation as fast as it is received from the cylinder, and no further decrease in viscosity is observed. Fig. 2 shows the results of analyses on several successive samples taken from the crankcase of such an engine in regular operation. This is comparable to the results obtained in stationary engines where "miles traveled" would be replaced by "hours of operation."

Results of Crankcase Dilution

Possibly this might occur on a great many types of engines, and we might infer that no serious trouble would result other than a steady loss of fuel that otherwise might have been used for the production of power. Unfortunately, this point of equilibrium might easily be at such a low viscosity that satisfactory lubrication could no longer be secured, the pistons and cylinders would begin to wear excessively, bearings would wear and the entire engine would gradually go to pieces. It has frequently happened that pistons have seized in the cylinder of an engine for no other reason than the use of oils of too low viscosity and too high volatility caused through excessive dilution of the oil by fuel.

Sometimes dilution can be reduced by increasing the viscosity of the lubricating oil, but the better plan is to correct the trouble at its source by improving the conditions of combustion so as to prevent fuel condensation.

The rotor of a single-phase motor of the shaded-pole type will turn in a direction toward the pole tips that the shading coils are on. Therefore, to reverse the direction of rotation it will be necessary to place the shading coils on the opposite pole tips, but in some cases this cannot be done for the shading coils do not always pass through the center of the pole faces. Where this cannot be done, it will be necessary to remove the laminated field structure from its shell and place it in the opposite way.

The Flash Evaporator*

Description of a New Type of Apparatus for Producing Distilled Makeup Water

AN ARTICLE published in the Sept. 19, 1922, issue of *Power*, treated broadly of the application of evaporators in stationary power plants. The several types of apparatus described differed considerably in design, but were similar to the extent that all of them made use of tubes in the evaporator body with steam or vapor inside the tubes and raw water outside. The present article, which is part of the same series on feed-water treatment, describes a type of evaporator fundamentally different in that evaporation takes place in a chamber containing no tubes. This is accomplished by circulating the raw water continuously through a closed heater, operated by exhaust steam, to a vacuum flash chamber or evaporator and then back to the heater.

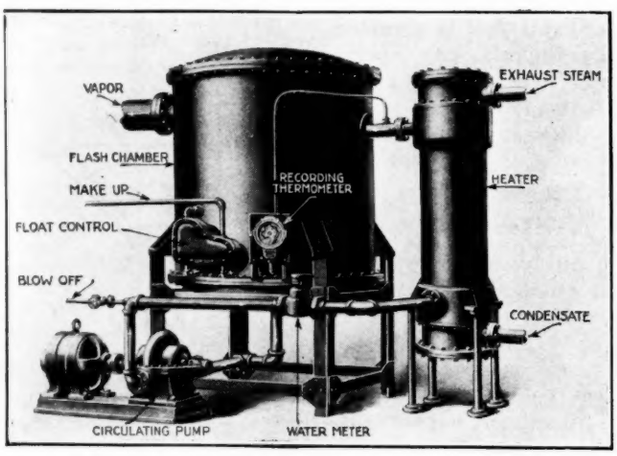


FIG. 1—SINGLE-EFFECT FLASH EVAPORATOR

The general arrangement for a small unit of this type is shown in Fig. 1, which illustrates a single-effect Schutte-Koerting Flash Evaporator. Here the motor-driven centrifugal pump circulates the raw water continually from the heater to the flash chamber and back to the heater. In the apparatus shown, the vapor-discharge line of the flash chamber may be connected to the main-unit condenser or to a special "distiller" condenser. In this way a vacuum is maintained such that the temperature of the raw water leaving the closed heater is considerably above that corresponding to the absolute pressure in the flash chamber. The result is that as the water enters the chamber, a certain fraction of it flashes into vapor. This passes off to the condenser and enters the system as distilled makeup water. The weight thus lost as vapor during each round trip of the circulating water must, of course, be made up by new raw water. The figure shows the makeup supply pipe and the box containing the float control. The amount of new makeup is somewhat greater than the weight of vapor given off, because there must, of course, be a continuous blowdown to keep the concentration from getting beyond a certain point. As this blowdown is only a small percentage of the raw makeup, the latter is only slightly greater than the amount of distilled makeup produced. The percentage of the total circulating water that flashes into vapor on each passage through the evaporator body can easily be figured if the temperature of the water leaving the heater and the vacuum in the evaporator are known. Suppose, for example, that the water leaves the heater at 205 deg. F. and passes into an evaporator body where the vacuum is 20 in. (30-in. barometer). The absolute pressure in the condenser is then 10 in., corresponding to a temperature of 161.5 deg. In dropping from 205 deg. to 161.5 deg., each pound of water must give up 205 — 161.5 = 43.5 B.t.u. The latent heat of steam at 161.5 deg. F. is 1,001 B.t.u., so the weight of water evaporated per pound of circulating water would be 43.5 ÷ 1,001 = 0.0435, or 4.35 per cent during each passage through the flash chamber.

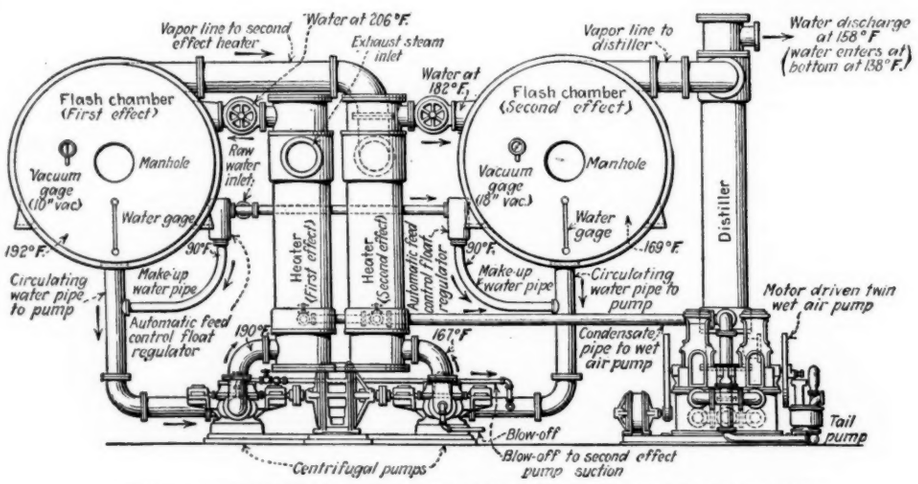


FIG. 2—ELEVATION OF DOUBLE-EFFECT FLASH EVAPORATOR

As the latent heat does not vary greatly with the temperature or pressure, the same temperature depression would produce approximately the same percentage of flash without regard to the actual value of the original temperature. In fact, for rough estimating purposes a fairly close idea of the amount of flash may be obtained by allowing one per cent of flash for each ten degrees of temperature depression.

Fig. 2 shows in elevation a double-effect installation. Operation is as follows: The centrifugal pump at the left circulates raw water continuously from the first-effect heater to the first-effect flash chamber and back

*The following articles have so far appeared in the series on feed-water treatment: "Softening Boiler Feed Water with Zeolites," Sept. 12, 1922; "Evaporators in the Stationary Power Plant," Sept. 19; "Corrosion—Its Cause and Cure," Oct. 3; "Corrosion—Apparatus to Prevent It—I.," Oct. 24; "Corrosion—Apparatus to Prevent It—II., Nov. 7; "How the Lillie Evaporator Operates," Nov. 21.

to the heater. The first-effect heater is operated by exhaust steam. By means of a float-controlled valve, a definite small proportion of raw water is continually admitted to the circulating water as it leaves the flash chamber, while the continuous blowdown is tapped off just beyond the pump outlet and passes to the inlet of the second-effect pump. The temperatures given on this diagram merely illustrate one possible set of conditions, the raw water here entering the first-effect flash chamber at 206 deg. F. and immediately dropping to 192 deg., on account of the 10-in. vacuum. This temperature is further reduced to 190 deg. by the addition of a small amount of raw makeup water at 90 deg. The vapor flashing from the first effect heats the second-effect circulating water in the second-effect heater. This circulating water leaves the second-effect heater at 182 deg. F. and passes to the second-effect flash chamber where a vacuum of 18 in. is maintained. Here flashing occurs with a fall in temperature to 169 deg. The vapor produced passes to a small surface condenser called a "distiller," where it is condensed in giving up its heat to the feed water. The condensed vapor from the distiller, as well as the first-effect vapor condensed in the second-effect heater, is removed by a motor-driven twin wet-air pump and thereby delivered to the hotwell ready for use by the feed-water pump.

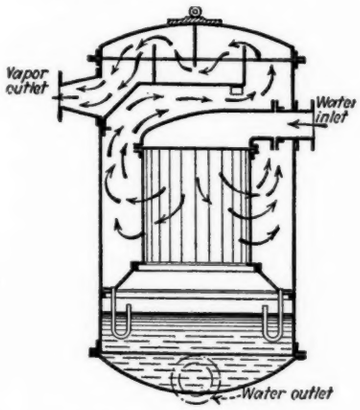


FIG. 3—CROSS-SECTION OF FLASH CHAMBER

Construction of the Flash Chamber

A diagrammatic cross-section of an evaporator body or flash chamber is shown in Fig. 3. This is of the vertical type like that used in the single-effect installation pictured in Fig. 1. While flashing will, of course, take place whenever water passes into a space where the pressure is less than that corresponding to the temperature of the entering water, it is important to make provision for a clean separation of the vapor from the liquid. This is accomplished by an arrangement of baffles and diagrams. The heated raw water, entering at the indicated point, passes down through radial slots to vertical corrugated iron sheets radiating out from the axis of the shell. In flowing down over these sheets, a large water surface is exposed. This permits clean separation of the "flashed" vapor from the remaining water. The vapor passes out through baffles which remove any remaining moisture, while the water is discharged at the bottom to be recirculated.

As in the case with other types of low-pressure evaporators, the upper and lower temperature limits may be changed to meet various operating conditions. Where a distilling condenser ("distiller") is used, it may be of either the surface-condenser or jet-condenser type. The former is used wherever it is necessary to keep the main condenser condensate—when it is used as the circulating water of the distiller—separate from the distillate; or where the raw evaporator feed is first used as circulating water for the distiller. Where the jet condenser can be used, it is cheaper and is of value as a deaërator for the condenser circulating water.

The following advantages are claimed for the flash evaporator: Elimination of evaporator scale trouble; removal of air and other gases; automatic control of evaporator feed and evaporator blowdown; and high rate of heat transmission in the heater, due to the absence of a steam film between the tubes and the surrounding water.

Measurement of Power Factor

By Victor H. Todd

In order to get comprehensive results in the measurement of power factor in a polyphase unbalanced circuit, much depends on what the operator regards as power factor, on the type of instrument used and on how it is connected. It is generally recognized that power factor in a three-phase circuit is the ratio between the true watts and the apparent watts; yet to the writer's knowledge there is no instrument that measures this to the letter. They measure various quantities that approach this definition only under specific conditions.

For example, one type indicates "power factor" by virtue of the varying torque between two single-phase wattmeter elements connected similarly to a single-phase wattmeter. Under accurately balanced loads and voltages this instrument theoretically gives a correct indication. Under unbalanced conditions its indications are worthless.

Another type contains three current coils acting on a movable iron vane polarized by a voltage winding. This will approximate the average cosine of phase-angle difference in accordance to its own law, but on circuits where the load is unbalanced and the power factor of each phase is different, its indications do not mean anything. This same type is made with three voltage windings and one current winding with an ammeter switch to change from one line to the other, thus reading each phase separately instead of an average. This, however, is affected by unbalanced voltage and wave form.

The dynamometer type with two voltage coils and one current coil, when used with an ammeter switch, gives good results except on badly unbalanced voltages and wave forms. Another method used extensively is to connect three single-phase instruments to record the power factor of each phase separately.

Where the instruments give readings that are not consistent, the discrepancy may be due to the type of instrument used, the method of connecting, unbalanced load, cross-currents, unbalanced current or voltage, or distorted wave form. For a check on conditions observe the reading of the polyphase wattmeter, or the demand from a kilowatt-hour meter, and divide this by the sum of the products of the current per phase and the voltage from this phase to neutral (volts between phases divided by 1.732). This will give the average power factor of the generator.

In pumping installations for the handling of fuel oil, it has been found that the best results are obtained where an air cushion is installed on both the suction and discharge sides of the pump. For constant, non-pulsating service the rotary type has been found very satisfactory. Needless to say, such a pump must be fully protected by removable screens or strainers.

Repairing an Open Circuit in a Series Winding*

By B. A. BRIGGS

EXPLAINS why heating may result if, when repairing an open circuit in a series winding, a jumper is placed on each pair of segments between which a burned spot develops.

EVERY ONE familiar with the operation of direct-current machinery, knows that when an open circuit occurs in one coil in a series winding, a burned spot develops on the commutator for each pair of poles. That is, in a 4-pole machine there will be two burned spots 180 deg. apart, and in a 6-pole machine three burned spots will occur on the commutator 120 deg. apart. For example, in the 4-pole winding, Fig. 1, if an open circuit develops in coil 14 at *X*, assuming the machine to be a generator and turning in the direction of arrows *K*, a burned spot will be produced between segments 7 and 8 and segments 20 and 21. This trouble may be remedied by connecting segments 7 and 8 or segments 20 and 21 together with a jumper. If segments 7 and 8 are connected together with a jumper as indicated by the full line, the defect will be closed; but if a jumper is also put on segments 20 and 21, heating will develop in the winding.

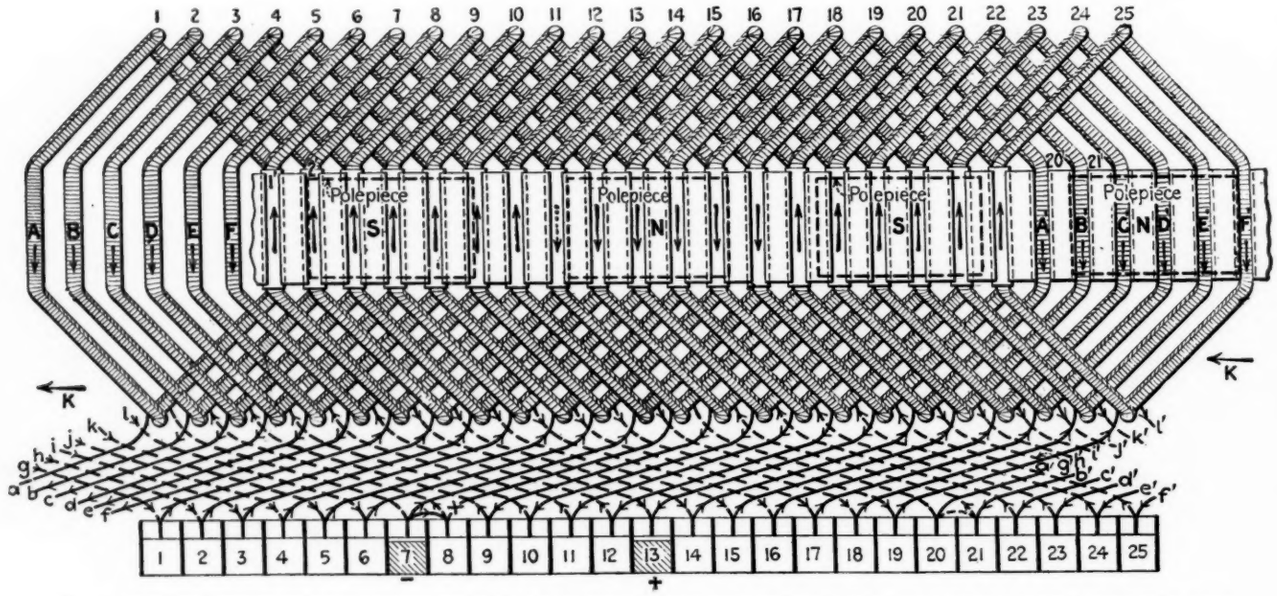


FIG. 1—SHOWS CIRCUITS THROUGH SERIES ARMATURE WINDING WITH OPEN-CIRCUITED COIL BRIDGED OUT OF CIRCUIT SO AS NOT TO CAUSE HEATING OF THE WINDING

Before the defect occurred in coil 14 at *X*, one of the circuits through the winding was from segment 7, through coil 1 to *a* and *a'*, coil 14 to segment 8, then through coil 2 to *b* and *b'*, through coils 15, 3, etc. until the circuit is completed at the + brush or segment 13. With the open circuit in coil 14 at *X*, the circuit is interrupted, but can be closed by connecting segments 7 and 8 together as shown by the full line. With segments 7 and 8 connected together, the circuit is from segment 7 to 8, then through coil 2 to *b* and *b'* and through coil 15 to segment 9, through coils 3, 16, etc., until the circuit is completed at the + brush on segment 13. It will be seen from this that not only is the defective coil 14 cut out of circuit, but also a good coil, No. 1. If, instead of connecting segments 7 and 8 together, the jumper is put onto segments 20 and 21, as indicated by the dotted line, the open circuit will be closed in the winding. Under this condition the circuit is from segment 7 through coil 1 to *a* and *a'* to segment 20, then through the jumper to segment 21, through coils 15, 3, etc., until the circuit is completed at the + brush on segment 13. In this case not only is the defective coil cut out of circuit, but also good coil No. 2.

To close the open circuit at *X* and only eliminate the defective coil from the circuit, the leads of this coil are located on the commutator, which in this case connect to segments 8 and 20. After the segments to which the defective coil connects are located, these two segments may be connected together with a long jumper, and this jumper tied down with the coil leads. This latter method of making the repair requires some testing to locate the leads of the defective coil and also some time to put the jumper in place, which necessitates the use of a soldering iron.

A thought that has occurred to many repairmen is, if connecting the two segments at one burned spot together repairs the fault, why not connect the two segments together at the other burned spot? Generally, when this was tried it resulted in heating the winding, after which one of the jumpers was removed, which stopped the heating, and the repairman went on his way thinking that he had caused a short-circuit in the winding by putting on the two jumpers. In fact, this is my

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own experience. I believed in the short-circuit theory for a good many years without investigating the real cause, and I have found many of my engineer friends who had the same belief and had not taken the time to find out differently. The fact is that no coils in the winding are short-circuited, but two coils in adjacent slots are connected in parallel and these having voltages of different values generated in them, a circulating current in the two coils results.

For example, in Fig. 1, assume that segments 7 and 8 are connected together, also 20 and 21; this connects coils 1 and 2 in parallel. Then apparently one of the circuits from the — brush is from segments 7 and 8, which are connected together, through coils 1 and 2 in parallel to *a* and *b*, then to *a'* and *b'* to segments 20 and 21, then through coil 15 to coil 3, etc., until the circuit is completed at the + brush on segment 13. From the figure it will be seen that, with the armature in the position shown, coil 1 is in slots 1′ and 20′, which are in the neutral position between the polepieces, consequently this coil has zero volts generated in it. Coil 2, which is in parallel with coil 1, is in slots 2′ and 21′ and is under the edge of the field poles, consequently has voltage generated in it, which will cause this coil to set up a circulating current between it and coil 1. Therefore the actual circuit in the winding is not as suggested for Fig. 1, but as shown in Fig. 2, which is from segment 7 to 8 through coil 2 to *b* and *b'* to segment 21 through coils 15, 3, etc., until the circuit is completed at segment 13. In addition to this, coil 2 will cause a current to flow through coil 1. This circuit is from coil 2 to segment 21, through the jumper to segment 20, to *a'* and *a* through coil 1 to segment 7, through the jumper to segment 8 and back to coil 2. It will be seen that this circuit does not interfere with the path through the winding for the current supplied to the external load, which may be connected to the + and — brushes.

Even though the difference of potential between coils 2 and 1 may be small, the resistance of the two coils is low, consequently a current of sufficient value may be caused to circulate to produce series heating of these coils. If the machine had interpoles, then the conditions would be even more favorable for circulating currents between coils 1 and 2. With the direction of rotation indicated by arrows *K*, Fig. 2, slot 1′ would be under a North interpole and slot 20′ under a South interpole. The interpoles being of opposite polarity to the main poles that coil 2 is under, a voltage will be induced in coil 1, opposite to that in coil 2, consequently this will assist in increasing the circulating current through these two coils and cause even more serious heating than without interpoles in the machine. Although the conditions shown in the figure are the most favorable for producing a circulating current in coils 1 and 2, in every position under the polepieces these coils will have voltages induced in them of different values, which will result in the coil of the highest voltage causing a circulating current through itself and the one of the lower voltage.

In Fig. 2 coil 2 has to carry not only the load current, but also the circulating current, and the two currents combined may cause heating destructive to the coil's insulation. When a small inequality in spacing between the brushes around the commutator may cause circulating currents between the different groups of brushes greater than the full-load current of the machine, it is easy to understand how the small difference of potential between two coils can cause circulating currents sufficient to overheat the coils.

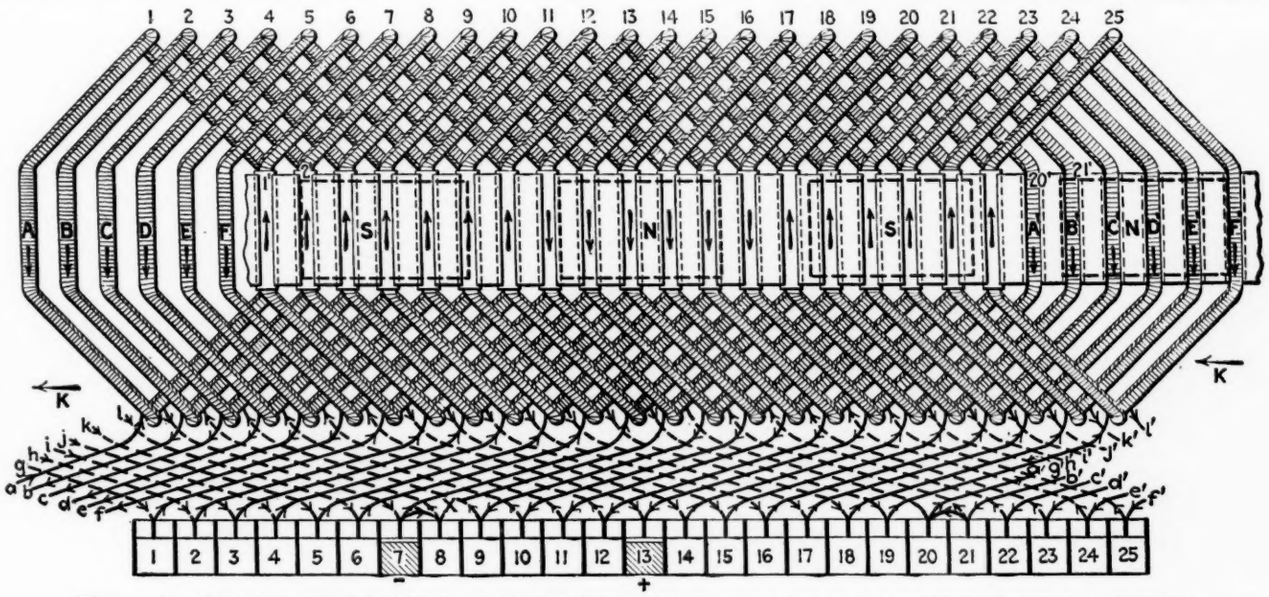


FIG. 2—IF OPEN-CIRCUITED COIL IN A SERIES WINDING IS BRIDGED OUT OF CIRCUIT WITH A JUMPER AT EACH BURNED SPOT, HEATING WILL RESULT

There is one condition under which no heating would be produced; that is, where the two coils are in the same slots, such as where two coils are taped together. When the two coils are in the same slots, they will have the same voltage induced in them, consequently can operate in parallel. However when closing the open circuit in a series winding by connecting the two segments together at a burned spot on the commutator, it is best to put on a jumper at one burned spot only and forget what else it might be possible to do. On the other hand if time will permit and the equipment is at hand to do it, the best scheme is to connect the two segments together with a long jumper, to which the open coil connects and cut this coil out of circuit, which is the practice followed in most repair shops.

Marine Diesel Engine Builder Enters Stationary Power-Plant Field

THE New London Ship and Engine Company was the pioneer builder of marine Diesel engines in the United States, many of the U. S. Navy submarines being propelled by engines of this make. Realizing that the largest fields for Diesel engines at the present time are the central stations and industrial plants, a 600-hp. stationary Diesel has been brought out. While originally intended for marine work, this engine has been equipped with a special governing device, extended shaft and outboard bearing to meet the requirements of industrial or electric power plants. The exterior view of the engine is shown in Fig. 1. The frame rests upon a girder sub-base having a closed crankpan. The frame is extended to form the jacket for the cylinder liners. The size of the engine is such that a single frame casting would prove too large, so the engine is divided at the center; three cylinders are mounted upon each frame casting, the frames being bolted together to form a rigid support for the cylinders.

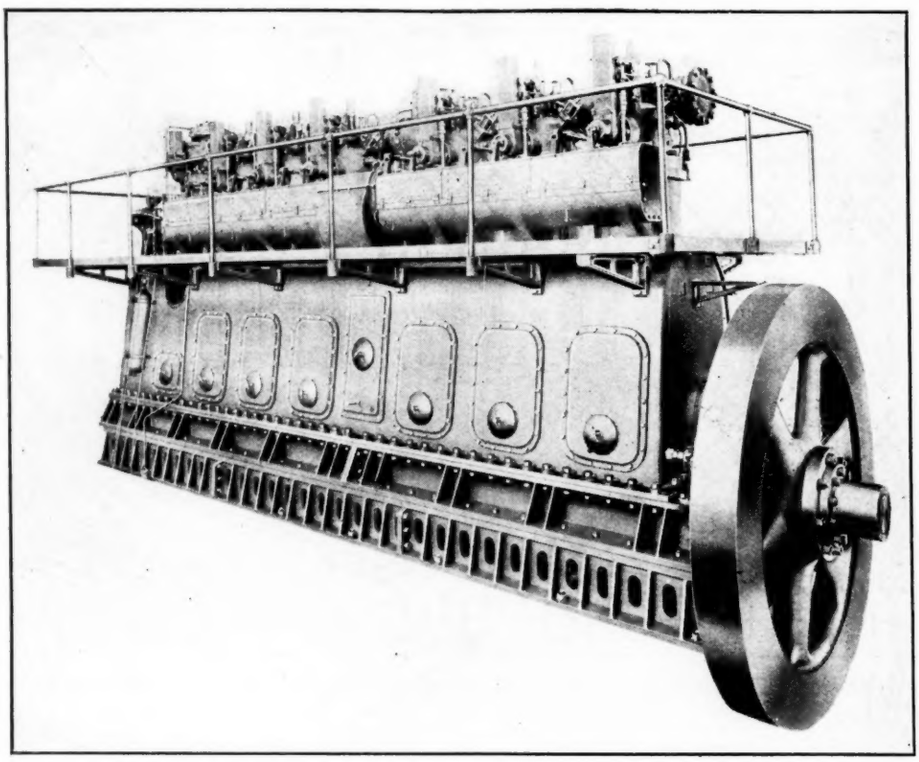


FIG. 1—NEW LONDON SIX-HUNDRED-HORSEPOWER DIESEL ENGINE

The six cylinders are 16.5 in. in diameter by 24 in. stroke and develop 600 b.hp., the indicated horsepower per cylinder being approximately 120.

The cylinder liner is pressed into the jacket, being sealed by a rubber gasket at the lower joint and by a flange at the upper or cylinderhead face. Since the engine operates on the four-stroke cycle, the cylinder head is fitted with one admission and one exhaust valve, together with the fuel spray valve, air starting valve and relief valves.

The combustion space, unlike that in many engines, does not consist of a flat cylindrical volume between a flat piston head and a flat cylinder head. To overcome the objectionable feature of this type of combustion chamber, which presents a large cooling area per unit of volume, the New London engine has the combustion space located in the cylinder head. This gives a maximum combustion volume per unit of surface area. The cooling effect is reduced, and since the air charge is concentrated about the fuel valve, the mixing of the fuel and the air is improved.

To operate the several valves, a layshaft is placed along the engine at a level with the top of the cylinders. This layshaft carries the required valve cams and is driven by a train of gears from the crankshaft, as shown in Fig. 2.

It is claimed that this gear drive is superior to the usual vertical helical gear shaft by reason of the absence of excessive wear of the usual helical gear. The train of gears is located in the center of the engine; this serves to decrease the torsion of the layshaft, since it is but one-half as long as when the drive is at the end of the engine. The fuel spray valve is illustrated in Fig. 3A. The type of atomizer is somewhat different from the prevailing type using a series of atomizing disks. The flame plate carries a single central opening, for since the combustion chamber concentrates the air immediately below the fuel valve, it is not necessary to have a number of orifices as are needed with cylindrical-shaped combustion spaces.

The exhaust valve, Fig. 3B, rests on a removable seat in the cylinder head, and is fitted with a shroud to eliminate the burning of the stem by the hot gases. The admission or air valve is provided with a cage so that the valve may be removed from the cylinder head without disassembling.

The air compressor is made three-stage, the dimensions being those shown in Fig. 4. In order to separate the air compressor from the crankcase a crosshead and piston rod are used. Both intercoolers and aftercoolers are incorporated in the compressor design.

The fuel pump is provided with a separate plunger for each working cylinder and is driven directly from

the crankshaft by means of a vertical shaft and suitable gearing, at one end of the engine as shown in Fig. 4. On this vertical shaft is mounted the governor, which is of the constant-speed type for engine designed for belt or direct-connected drive.

The lubricating system used can best be described by calling it a gravity forced feed. With this system the lubricating oil flows from the gravity tank, which is at a sufficient height above the engine crankshaft to give the proper pressure to the main bearings, thence through holes in the crankshaft to crankpins and up the inside of the connecting rods to the wristpins. The crankcase is inclosed and all surplus oil drains to a suitably formed trough in the bottom of the bedplate from whence it is pumped back through suitable strainers to the gravity tank. All the important bearings are thus under forced lubrication, and a free flow of oil is flowing through them at all times. The camshaft parts are oiled by splash from oil carried in the bottom of the trough of the camshaft casing. All cylinders and exhaust-valve stems are taken care of by mechanical oilers, and the minor valve-gear bearings are fitted with oil cups for hand oiling.

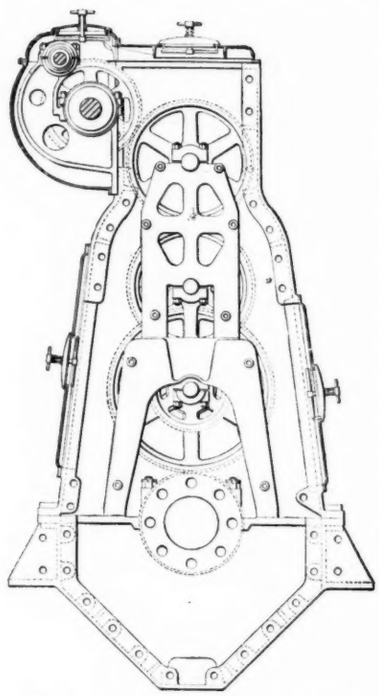


FIG. 2—CAMSHAFT GEAR DRIVE

The fuel consumption on tests was found to be as follows: Full load, 0.42 lb. per b.hp.-hr.; ¾ load, 0.45 lb. per b.hp.-hr.; ½ load, 0.51 lb. per b.hp.-hr.; ¼ load, 0.67 lb. per b.hp.-hr.; 1¼ load, 0.42 lb. per b.hp.-hr.

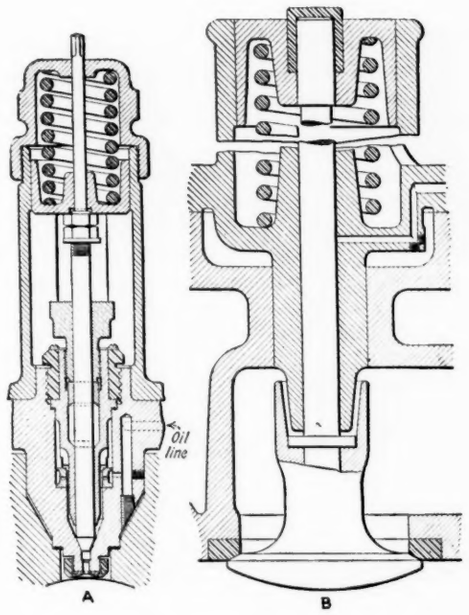


FIG. 3—FUEL AND EXHAUST VALVES

All the working parts are completely inclosed, which not only makes the engine attractive in appearance, but also eliminates all danger from dust and grit. The crankcase is made accessible by large doors, placed in line with each working piston and with the gear train and air compressor.

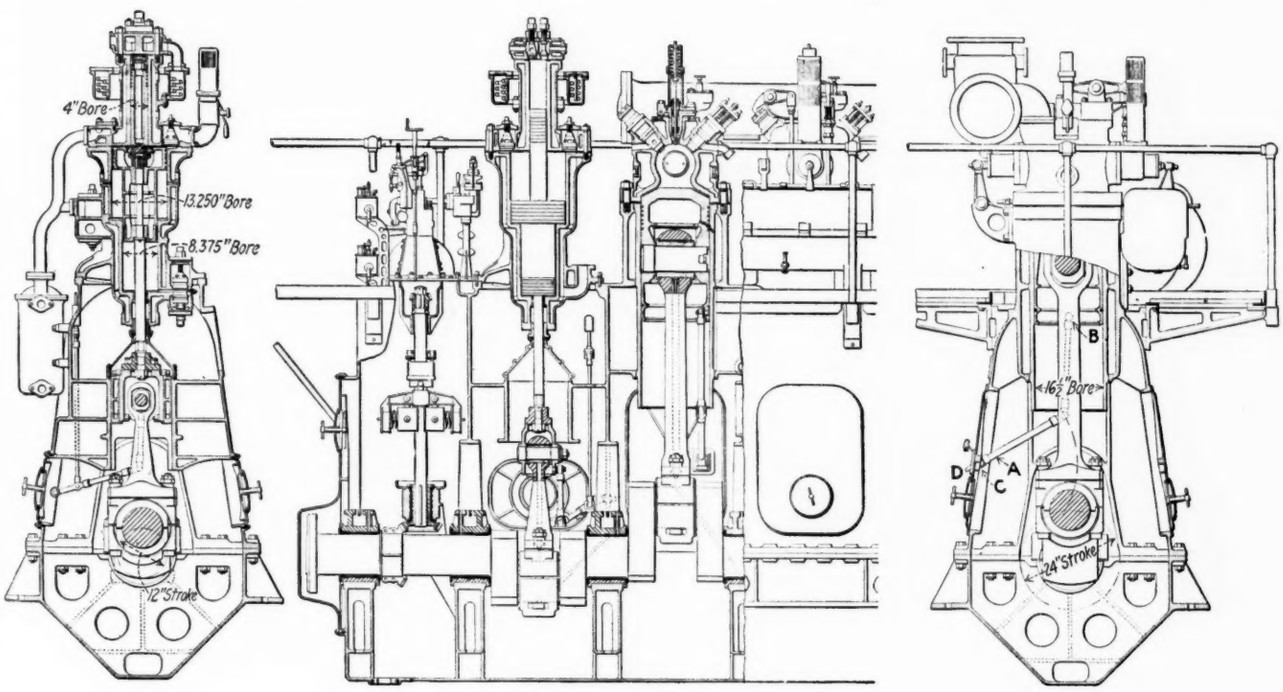


FIG. 4—CROSS-SECTION OF ENGINE

Ohio Industries Are Nearly Half Engine Driven, as Compared with Motor Drive

Ranking third industrially in 1920, Ohio possesses slightly more installed private horsepower than the second state, New York; one-third of its drives use purchased electrical power

THE industrial survey of the various states conducted by *Power* and the *Electrical World* has received 1,243 returns from a total of 2,294 mines and factories scattered throughout Ohio, indicating a fine spirit of co-operation and giving an excellent basis for estimating the power conditions. Returns have been grouped into nineteen general industries, analyzed in the tables attached.

Notwithstanding the fact that Ohio, the third industrial state, contains slightly more installed prime-mover and motor horsepower than New York, which is second, the latter consumes much more electrical energy than Ohio or Pennsylvania. This is readily explained by the Niagara Falls electrical industries, which require vast quantities of electricity in electric-furnace processes, yet where no electric driving is represented. Table I for the year 1920 compares the first three industrial states.

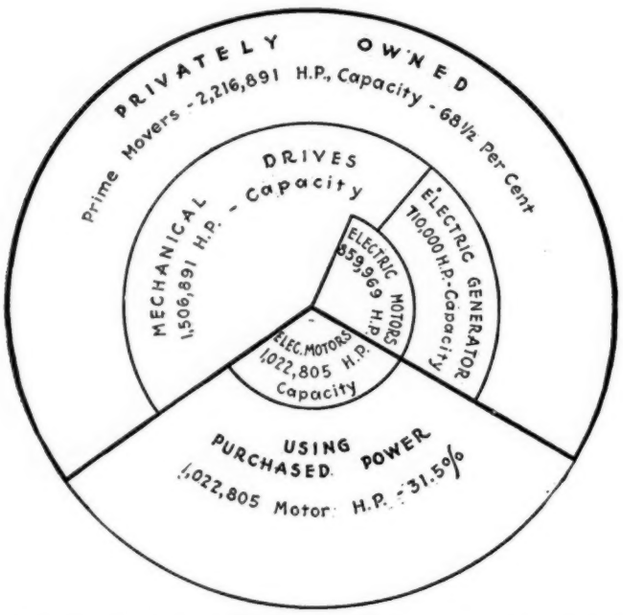


FIG. 1—PRIVATELY OWNED PRIME-MOVER CAPACITY IS DOUBLE THAT OF MOTORS USING PURCHASED POWER

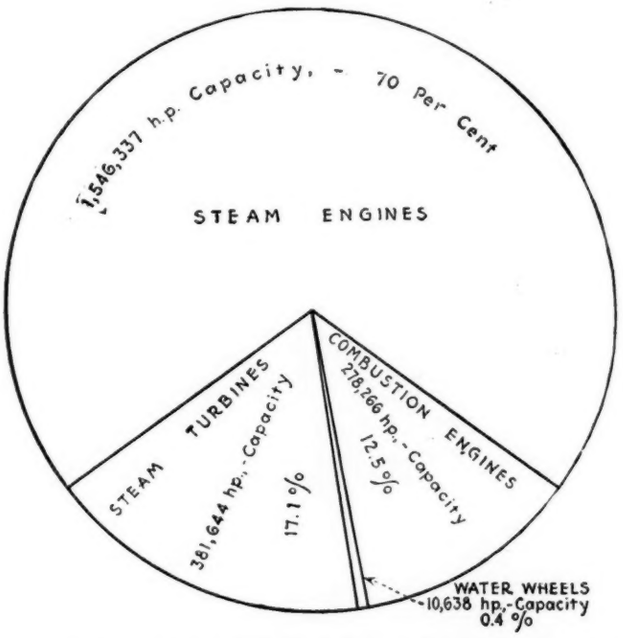


FIG. 2—STEAM ENGINES EXCEED TWO-THIRDS OF PRIME-MOVER CAPACITY

TABLE I—COMPARING INSTALLED HORSEPOWER AND CONSUMED ELECTRIC POWER, IN 1920

	Pennsylvania	New York	Ohio
Prime-mover horsepower	5,475,187	1,856,982	2,216,891
Electric-motor horsepower	2,663,168	1,704,300	1,882,774
Energy consumed, kilowatt-hours	4,666,928,000	4,856,565,000	2,820,452,000

The Ohio industries in general are on a comparatively independent and self-sustaining power basis. Privately owned prime movers, Fig. 1, represent twice the capacity of motors using purchased power. Motors using private power amount to 859,969 hp. which is 15 per cent less than 1,022,805 hp. of motors using purchased current. Privately generated electrical energy in 1920 was only 7 per cent less than that purchased, the former being 1,358,586,000 kw.-hr. against 1,461,866,000 obtained from public utilities. A notable feature is the extensive use of mechanical drives as compared with electrical motors; engines of 1,506,691 hp., together with motors using both purchased and privately generated current of 1,882,774 hp., drive the mills and factories. This does not include engines driving generators furnishing private power; the latter prime movers amount to 710,000 hp., or about half that used for mechanical drives. It is not always realized that engines for small or medium-sized plants possess such advantages over electrical drives. The old-fashioned lineshaft undoubtedly is cheaper and better than an equivalent generator and motor drive under certain conditions.

Steam engines and turbines, Fig. 2, represent over three-quarters of prime movers, while waterwheels are practically absent, being less than one per cent of prime-mover capacity. This is in marked contrast to Massachusetts, a power survey of which appeared in *Power* of June 27, 1922, disclosing 17 per cent in waterwheel power. The average steam engine, in round numbers, is 200 hp. in capacity; turbine, 125 hp.; internal-combustion engine, 40 hp.; and waterwheel, 100 hp.

TABLE II—IRON AND STEEL PRODUCTS EQUAL ALL OTHER INDUSTRIES IN POWER REQUIREMENTS

	Prime-mover Horsepower	Generated Kilowatt-hours	Purchased Kilowatt-hours
Iron and steel products	1,104,334	765,000,000	678,500,000
All other industries	1,112,557	593,586,000	783,366,000

TABLE III—ALTERNATING-CURRENT MOTOR-OPERATING VOLTAGES OF INDUSTRIAL PLANTS IN OHIO

Industry	Number of Companies Reporting Various Motor-Operating Voltages																				
	90	110	120	125	160	210	220	225	230	235	240	250	410	440	450	460	480	500	550	2,200	2,300	3,800
Bituminous coal mining	..	...	...	...	...	...	6	...	...	...	...	...	...	2	...	...	...	...	...	1	1	....
Chemicals	..	1	...	...	...	...	9	...	...	...	...	...	...	3	...	...	...	...	...	....	....	....
Electrical equipment and machinery	..	3	...	...	...	...	12	...	...	...	...	...	...	5	...	...	...	...	...	1	....	....
Food and kindred products	..	4	...	...	...	...	22	...	...	...	...	...	...	5	...	...	...	...	...	2	1	....
Iron and steel and their products	..	6	...	1	...	1	117	...	9	1	...	3	...	45	...	...	...	2	...	10	5	....
Leather and its products	..	4	...	...	...	...	9	...	...	...	...	...	...	2	...	...	...	...	...	....	....	....
Lumber and its products	..	3	...	...	...	...	10	1	...	...	...	...	...	3	...	...	...	...	...	....	....	....
Metals and metal products other than iron or steel	..	1	...	...	...	...	9	...	...	...	...	1	...	4	...	...	...	..	...	1	1	....
Paper and printing	..	2	...	...	...	...	8	...	...	...	...	...	1	7	...	...	...	1	...	....	....	....
Railroad repair shops	..	...	...	...	...	...	2	...	...	...	1	...	1	3	...	...	1	...	...	....	....	....
Rubber	1	...	...	2	1	...	3	...	1	...	...	6	...	13	1	...	...	...	1	2	1	1
Stone, clay and glass	..	2	...	...	...	1	20	...	...	...	...	1	...	6	...	1	...	...	...	2	....	..
Textiles	..	2	1	...	...	...	14	...	...	...	1	...	...	2	...	...	...	...	...	....	....	....
Tobacco	..	4	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	....	....	....
Vehicles for land transportation	..	...	...	...	...	...	8	...	2	...	...	1	...	4	...	...	...	...	...	....	....	....
Miscellaneous	..	...	1	...	...	...	11	...	1	...	...	...	...	7	...	...	...	...	...	....	....	....
Totals for all industries of Ohio	1	32	2	3	1	2	262	1	13	1	2	12	2	111	1	1	1	2	2	19	9	1

TABLE IV—ESTIMATE OF TOTAL PRIME MOVER EQUIPMENT IN INDUSTRIAL PLANTS OF OHIO

Industry	Total Rating of Prime Movers in Industrial Plants	Steam Engines		Steam Turbines		Internal Combustion Engines		Waterwheels	
		No.	Hp.	No.	Hp.	No.	Hp.	No.	Hp.
Bituminous coal mining	84,578	650	79,949	4	3,275	120	1,354	0	0
Chemicals	54,184	121	33,890	11	18,002	18	1,884	4	408
Electrical equipment and machinery	7,271	22	4,533	1	670	10	2,068	0	0
Food and kindred products	157,514	754	121,881	100	11,371	128	18,024	68	6,238
Iron and steel and their products	1,104,334	2,600	810,541	98	218,656	477	74,437	5	700
Leather and its products	8,245	28	6,818	1	822	4	550	1	55
Lumber and its products	55,621	264	48,300	2	657	53	6,544	1	120
Metals and metal products other than iron or steel	55,351	148	35,816	2	3,799	125	15,426	3	310
Paper and printing	71,849	206	55,069	18	11,627	66	3,024	36	2,129
Petroleum and natural gas (not refining)	153,083	1,172	24,274	0	0	6,134	128,809	0	0
Quarries	35,151	419	34,162	0	0	56	961	1	28
Rubber	111,821	62	32,043	29	77,657	15	1,792	3	329
Stone, clay and glass	146,433	928	122,843	4	10,720	173	12,720	1	150
Shipbuilding	6,724	27	6,617	1	10	1	97	0	0
Textiles	7,938	25	6,124	4	1,120	5	644	1	50
Tobacco	87	1	50	0	0	1	37	0	0
Vehicles for land transportation	15,739	54	12,967	1	440	19	2,332	0	0
Miscellaneous	106,736	255	83,483	15	17,631	45	5,501	1	121
Railroad repair shops	34,226	111	26,977	3	5,187	17	2,062	0	0
Totals for all industries of Ohio	2,216,891	7,847	1,546,337	294	381,644	7,467	278,266	125	10,638

TABLE V—ESTIMATE OF THE USE OF ELECTRICAL ENERGY IN OHIO IN 1920

Industry	Electric Generators				Electrical Energy Consumed		
	Direct Current		Alternating Current		Generated in Private Plants, Kw.-hr. (1920)	Purchased from Public Utilities, Kw.-hr. (1920)	Total Energy Consumed in 1920
	No.	Total Rating, Kw.	No.	Total Rating, Kw.			
Bituminous coal mining	60	7,590	16	1,310	21,650,000	29,200,000	50,850,000
Chemicals	26	2,120	8	2,040	18,700,000	26,070,000	44,770,000
Electrical equipment and machinery	26	6,550	8	2,000	18,900,000	48,250,900	67,150,000
Food and kindred products	68	8,120	22	3,220	49,150,000	108,200,000	157,350,000
Iron and steel and their products	622	133,200	236	198,800	765,000,000	678,500,000	1,443,500,000
Leather and its products	15	2,360	3	406	3,848,000	6,385,000	10,233,000
Lumber and its products	10	533	7	1,120	2,540,000	8,370,000	10,910,000
Metals and metal products other than iron or steel	69	12,400	22	7,560	50,400,000	123,000,000	173,400,000
Paper and printing	37	11,400	9	5,560	64,100,000	64,900,000	129,000,000
Railroad repair shops	28	2,580	9	2,700	20,040,000	27,720,000	47,760,000
Rubber	49	13,000	49	45,500	194,000,000	99,000,000	293,000,000
Stone, clay and glass	101	28,300	6	700	67,000,000	92,300,000	159,300,000
Textiles	20	4,000	8	1,880	5,960,000	7,220,000	13,180,000
Tobacco	0	0	0	0	0	443,000	443,000
Vehicles for land transportation	9	1,130	2	270	3,392,000	40,600,000	43,992,000
Miscellaneous	91	17,500	29	4,250	66,000,000	72,200,000	138,200,000
Shipbuilding	5	1,000	2	2,660	3,720,000	7,023,000	10,743,000
Petroleum and natural gas (not refining)	1	82	0	0	36,000	135,000	171,000
Quarries	6	1,683	2	234	4,150,000	22,350,000	26,500,000
Totals for all industries of Ohio	1,243	250,548	438	280,210	1,358,586,000	1,461,866,000	2,820,452,000

TABLE VI—ESTIMATE OF NUMBER AND RATING OF MOTORS INSTALLED IN INDUSTRIAL PLANTS OF OHIO

Industry	Motors Run by Purchased Energy		Motors Run by Energy Generated in Private Plants		Total Motors in All Plants		Motors under 5 Hp.	Distribution of Drives		
	Number	Total Rating, Hp.	Number	Total Rating, Hp.	Number	Total Rating, Hp.		Belt	Chain	Directly Connected
Bituminous coal mining	1,647	51,447	1,498	38,145	3,145	89,592	385	1,025	142	1,978
Chemicals	3,290	26,436	2,360	18,960	5,650	45,396	1,910	3,734	166	1,750
Electrical equipment and machinery	4,480	36,144	1,760	14,150	6,240	50,294	3,315	4,123	184	1,933
Food and kindred products	4,970	58,372	2,260	26,561	7,230	84,933	3,025	3,401	953	2,876
Iron and steel and their products	19,720	368,541	22,300	416,508	42,020	785,049	7,080	17,003	1,063	23,954
Leather and its products	1,260	7,060	760	4,260	2,020	11,320	379	1,758	157	105
Lumber and its products	2,010	26,589	610	8,056	2,620	34,645	1,078	2,180	12	428
Metals and metal products other than iron or steel	13,600	92,584	5,580	37,934	19,180	130,518	10,900	14,020	700	4,460
Paper and printing	1,770	32,096	1,750	31,650	3,520	63,746	1,924	2,846	74	600
Railroad repair shops	2,000	31,654	1,450	22,926	3,450	54,580	634	1,480	176	1,794
Rubber	2,560	58,581	5,040	115,006	7,600	173,587	5,510	3,034	349	4,217
Stone, clay and glass	2,680	55,559	1,950	40,388	4,630	95,947	1,737	2,530	322	1,778
Textiles	2,620	8,261	2,170	6,820	4,790	15,081	3,740	1,490	502	2,798
Tobacco	195	659	0	0	195	659	155	195	0	0
Vehicles for land transportation	6,550	73,608	386	4,333	6,936	77,941	2,890	5,385	131	1,420
Miscellaneous	5,390	74,116	4,930	67,747	10,320	141,863	6,640	5,586	538	4,196
Shipbuilding	294	7,495	156	3,983	450	11,478	197	66	8	376
Petroleum and natural gas (not refining)	11	137	2	37	13	174	4	13	0	0
Quarries	308	13,466	120	2,505	428	15,971	161	234	30	164
Totals for all industries of Ohio	75,355	1,022,805	55,082	859,969	130,437	1,882,774	51,664	70,103	5,507	54,827

Small direct-current generators numbering 1,243, which average 200 kw., together with 438 alternators averaging 640 kw., supply the privately generated power. Fourteen direct-current voltages are in use and twenty-two alternating voltages, while 40 to 50 per cent of the applications of both kinds are 220 volts. Eighty-five per cent of the companies reporting on motor switches used knife or safety type exclusively, or in conjunction with other starting equipment; 58 per cent used automatic starters and 41 per cent reported circuit breakers installed in plants or at mines.

The use of refillable or renewable fuses was reported by 302 of 325 companies, against 119 using standard fuses, while a large number reported the use of both types. Estimates show that 95,556 fuses of all types are used per month.

Largest Industrial Groups Compared

Fig. 3 gives a comparison of the nine largest industrial groups ranked in order of installed prime-mover horsepower. The presence of such a large proportion of steam engines in the iron and steel industries in-

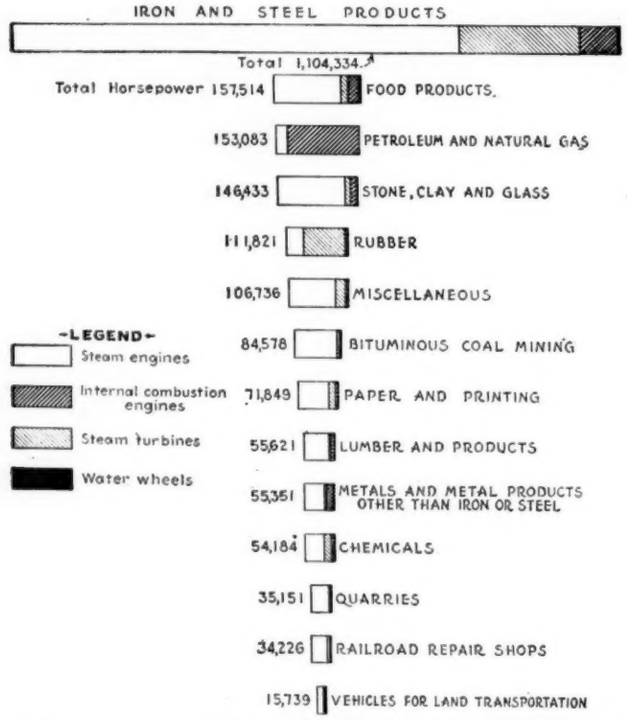


FIG. 3—STEAM ENGINES PREDOMINATE EXCEPT IN RUBBER AND PETROLEUM INDUSTRIES. FIVE SMALLEST GROUPS ARE NOT INCLUDED

dicates strongly that they are holding their own. The rubber industry, however, is largely turbine equipped, which is an exception to the usual prime-mover distribution. This may be influenced by the adaptability of electric drives for such processes. It is noteworthy that this industry contains a total of 173,587 hp. of electric motors, which exceeds that of any industry except iron and steel products, although the rubber group stands fifth in order of prime-mover horsepower.

While the iron and steel group equals all the remaining industries approximately in regard to installed primary horsepower, it purchased 13 per cent less and generated 29 per cent more energy than all other industries. Large steel mills are located in the Ohio Valley, adjacent to the Pittsburgh district, one of which contains a motor of 8,000 hp.

The great iron and steel group uses 2,600 steam engines averaging 310 hp. The electrical industry engine averages 200 hp.; leather and its product, 240 hp.; while the rubber manufacturing, an industry peculiar to Ohio, contains an average engine of 515 hp. The average turbine of the steel group is 2,200 hp.; that of the rubber group 2,600 hp.; stone, clay and glass, 2,680 hp., representing the largest group average units.

TABLE VII—DIRECT-CURRENT MOTOR-OPERATING VOLTAGES OF INDUSTRIAL PLANTS IN OHIO

	Number of Companies Reporting Various Motor-Operating Voltages													
Industry	110	115	120	125	210	220	225	230	240	250	440	500	530	550
Bituminous coal mining	..	..	..	..	1	7	..	2	..	21	..	..	..	2
Chemicals	3	..	..	..	..	3	..	1	..	..	1	..	..	..
Electrical equipment and machinery	4	..	..	1	..	5	..	2	..	..	1	..	..	..
Food and kindred products	5	..	..	..	..	4	..	2	..	..	..	..	..	..
Iron and steel and their products	11	2	..	..	1	56	1	19	3	14	1	1	2	..
Leather and its products	..	..	..	..	..	4	..	..	..	..	1	..	..	..
Lumber and its products	2	..	1	1	..	6	..	..	..	..	..	..	..	..
Metals and metal products other than iron or steel	2	..	..	..	..	3	..	1	..	..	..	..	..	..
Paper and printing	7	1	..	..	..	5	..	1	1	..	2	..	..	..
Railroad repair shops	1	..	..	..	..	1	..	1	..	1	..	..	..	..
Rubber	4	..	1	1	..	4	..	4	1	3	3	..	..	..
Stone, clay and glass	4	3	..	1	..	7	..	5	1	4	2	1	..	..
Textiles	4	1	..	..	..	9	..	..	..	..	..	..	..	..
Tobacco	..	..	..	..	..	1	..	..	..	..	..	..	..	..
Vehicles for land transportation	3	..	..	..	..	2	..	..	..	1	1	..	..	..
Miscellaneous	3	..	..	..	..	8	..	1	..	1	..	..	..	5
Totals for all industries of Ohio	53	7	2	4	2	125	1	39	6	45	12	2	2	7

The necessity for a metal having similar magnetic properties to brass and gun metal, but in price more nearly approaching that of cast iron, has long been felt by manufacturers of electrical equipment. Such a product is now on the market under the name of "No-Mag," a Dawson-Ferranti patent, an alloy which not only possesses the properties of gun metal but also has a higher specific resistance than ordinary cast iron. This metal combines the essential non-magnetic properties of gun metal and the high-resistance properties of cast iron. By its use in the construction of an alternator the hysteresis and eddy-current losses in the stator and end plates are reduced to a minimum, and magnetic leakage is largely prevented; the same applies to the covers over the end connections. In the case of armatures or rotors of direct- and alternating-current generators or motors, if non-magnetic iron end plates are used, the total flux is kept particularly confined to the armature core and magnetic leakage is again reduced to a minimum, the latter being important from the point of view of the reduction in the amount of copper which may be used. It can be cast with the same facility as ordinary cast iron, brass and aluminum and has the same appearance as the first named, with which it also compares equally as to strength and machining properties. The cost depends somewhat, as does that of ordinary cast iron, on the type of casting into which it is put, but can be taken as being between 20 and 50 per cent higher than that of gray iron.—*Electrical Review*, London.

A Unaflow Engine with an Unusual Valve Gear

DESCRIPTION of the Hamilton Unaflow Engine Valve Gearing. Method of Setting the Valves in Shop and Field.

THE unaflow engines of all makes follow in the main the principle of using a central exhaust, giving a one-directional flow to the steam. Nevertheless, in details of governors, cylinder arrangement and valve design each manufacturer has followed his own ideas.

Somewhat striking cylinder and valve-gear designs are incorporated in the Hamilton unaflow engine built by Hooven, Owens, Rentschler Co. The cross-section of the engine frame and cylinder appears in Fig. 1. The frame is of the bored-guide sidecrank type, and rests on the foundation along its entire length. The eccentrics that drive the valves are placed on a layshaft running along the frame. This layshaft is connected to the crankshaft by bevel gears and a drag crank. The governor, which is carried on the layshaft, is of the two-arm centrifugal type, and is inclosed in an iron case. The arrangement is shown in Fig. 2.

Steam Valves

The steam valves are unusual in that they are placed horizontally at the bottom of the cylinder, as illustrated in Fig. 3. These valves are of the double-beat poppet type and seat in removable cages. The cam end of the valve stem fits into a crosshead *A* carrying a roller *B*. This roller contacts with the cam *C* which is clamped on the short steam camshaft *D*. This camshaft is driven by the steam eccentric rod *H* by means of a rocker arm clamped to the steam camshaft. Only one steam eccentric is used, the two valve cams being fastened to the one steam camshaft.

In case of condensing engines relief valves are placed at each side of the cylinder and communicate with a clearance belt or passage around the cylinder. If for any reason it is necessary to run non-condensing, these valves are opened by hand, in this way adding to the cylinder clearance volume the volume of the auxiliary clearance.

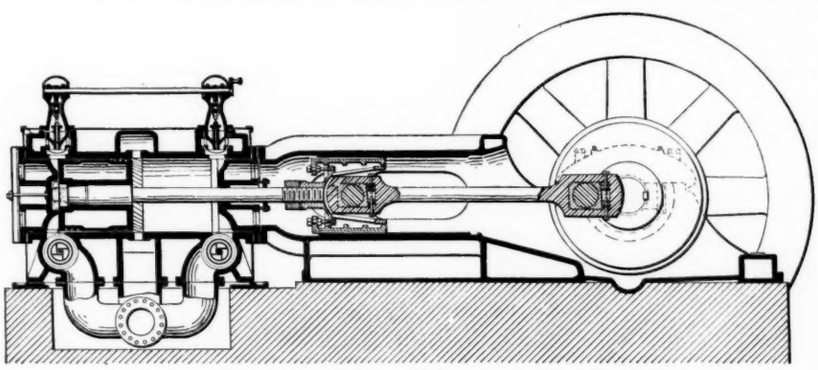


FIG. 1—CROSS-SECTION OF HAMILTON UNAFLOW ENGINE

For certain condensing work and for non-condensing operation the Hamilton engine is fitted with auxiliary exhaust valves placed on the top of the cylinder, as outlined in Figs. 1 and 3. These double-beat valves are controlled by cams fitted to a short camshaft along the cylinder top, which is driven by a single exhaust eccentric from the main layshaft.

The first step in setting the valves is to insure proper contact of the steam rollers and cams. The eccentric rod is disconnected and the cams are backed away from the roller as in position *A*, Fig. 4, by screwing out the center jackbolt *E* and running down the nuts *F* on the studs. The cam is gradually pushed toward the roller until it strikes at the center line of the cam, as shown at *B*. If the roller and cam are too far apart, as at *A*,

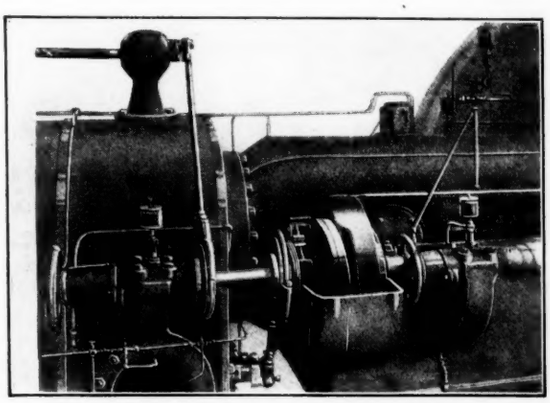


FIG. 2—GOVERNOR ASSEMBLY

they are very noisy when the shaft is reciprocated, but when brought to the proper point no noise or shock can be felt when rocking the camshaft. There must, however, be a slight clearance between the cam and roller to insure closure of the valve. When properly adjusted, the back of the cam is exactly vertical when contact is made with the roller.

The eccentric rod is then adjusted to make the distance from the center of the eccentric strap to the center of the stub end ¼-in. less than the distance from the center of the camshaft to the center of the governor or eccentric shaft.

The stub end is now connected to the camshaft lever and the side shaft coupling is disconnected, so that that part of the layshaft carrying the governor and eccentric is free from the portion geared to the engine shaft. The governor is then turned to bring the slide block at right angles to the eccentric rod, this position being reached when it is possible to move the governor weights in and out without moving the camshaft lever. This is the *lead* position. At this point clamp the dial which comes with the engine to the governor shaft and set it at 2 per cent lead by a stationary pointer. The dial has per cent of stroke marked on it rather than degrees. If the dial is not available, marks can be made on the shaft and bearing. Now revolve the shaft approximately one-half turn and the other cam should just begin to push its roller at 2 per cent lead. This is done with the governor springs removed, and the weights blocked half-

way out. With the governor weights at their extreme outer position the valves should not be opened at all by the cam. With the weights entirely in, maximum opening and cutoff are obtained. The cutoffs and openings are equalized by changing the length of the eccentric rods. The steam cams are fastened to the camshaft by a drilled hole and a flatted place on the shaft so that they cannot slip on the shaft. The lead is changed by shifting the governor-shaft coupling so that the eccentric is advanced in reference to the crankpin.

When the dial shows crank-end center, a mark is made on the coupling opposite the pointer mark on the bearing and stamped "crank-end center." The shaft is then turned a slight amount until the dial shows crank-end lead, and another mark is put in the coupling and lettered "crank-end lead." These two marks, which are made at the time the engine is tested at the factory, will enable an engineer to check up the valve setting at any time.

Setting Exhaust Valves

The mechanically operated exhaust valves should be set as follows: Disconnect the exhaust eccentric rod from the camshaft rocker and adjust the exhaust cams for quietness by screwing down the cap nut on the end of the exhaust-valve stem until the stem is too short; then gradually screw the nut up until the noise disappears, observing the precaution not to get the stem too long. Now reconnect the eccentric rod and set the cams by shifting the exhaust eccentric to its position of minimum travel. The governor shaft is next rotated until the exhaust camshaft is at one extreme of its travel and the proper cam is set to bring its flat side level or horizontal. It is now necessary to rotate the governor

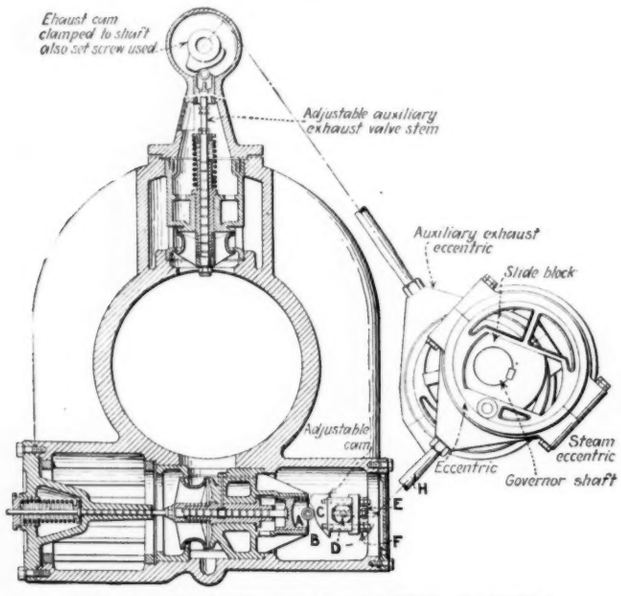


FIG. 3—CYLINDER CROSS-SECTION, SHOWING VALVE GEAR

shaft through about one-half a revolution until the other extreme of the camshaft oscillation is reached. The second cam is then clamped with its flat side level. If the setting has been properly done, the governor shaft can be turned through an entire revolution without causing either exhaust valve to open. When the eccentric is shifted to any position other than that of least travel, both valves should have equal lifts. This exhaust-valve gear is so designed that the valves open about 6 per cent of the stroke past dead center and may be adjusted by the handwheel to close at any point in the exhaust stroke up to 95 per cent. The lead is always constant.

The valve setting is completed by setting the engine crankpin on the crank-end dead center, rotating the governor shaft until the index of the bearing cap coincides with the line marked "crank-end center" on the coupling, and clamping the coupling.

If a valve-setting dial is not available, the same results may be obtained by first completing the adjustment

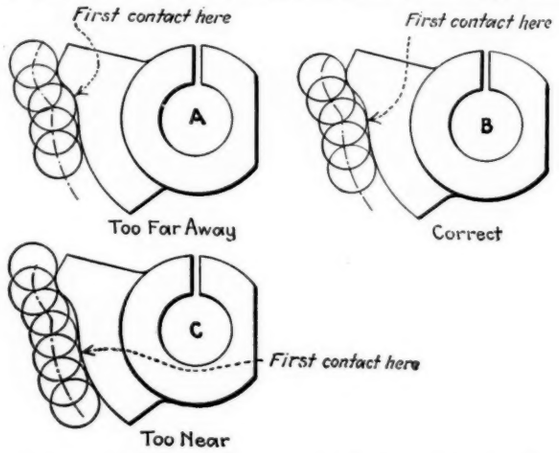


FIG. 4—CORRECT AND INCORRECT CAM CLEARANCE

of the steam cams, then with the index mark on the bearing coinciding with the "crank-end lead" pointer on the coupling, bring the main crosshead to a point 2½ per cent of the stroke ahead of the crank-end center position and clamp the layshaft coupling.

Pipe Joints for Carbon-Dioxide Refrigerating Machines

The pressures carried in a CO_2 refrigerating machine are high, the suction or evaporating pressure being around 300 lb. per sq.in., while the head pressure will range from 800 to 1,050 lb. per sq.in. For this reason ordinary pipe and pipe joints will not prove satisfactory. The pipe should be extra-heavy for the entire system. The most approved joint is one wherein the pipe is screwed entirely through the flange and faced off flush. The flange should then be screwed on about one-sixth of a turn, which leaves the faced pipe end protruding beyond the flanged. When the flanges are brought together, a copper ring gasket is slipped between the two pipe ends, after which the flange bolts are drawn up compressing the gasket between the pipe ends.

The bolts must be drawn up evenly to avoid damaging the gasket. After the joint is closed, it should be liberally coated with soapsuds and the system pumped up full of air to at least the working pressure. If any leaks exist, the air will form bubbles in the suds. It is seldom possible to stop the leak by tightening the bolts. The best way is to disconnect the piping and insert a new gasket.

If the liquid that is measured by a venturi meter contains scale-forming material so that a quantity of scale is formed within the neck of the venturi tube, the velocity of the liquid through this neck becomes excessively high and consequently causes the meter to read high. Tubes of venturi meters should be inspected at intervals to prevent this error.

Rochester Plant Installs Pulverized Fuel Burning Equipment

By R. D. DeWOLF
Chief Operating Engineer, Rochester Gas and Electric Corporation

A BRIEF decription of the pulverized-coal equipment which the Rochester Gas and Electric Corporation, Rochester, N. Y., is installing on two 8,750-sq.ft. Bigelow-Hornsby boilers may be of interest, and there have been incorporated in this plant several features of design that, it is felt, are rather unusual, and it is hoped they will mark another step forward in the development of pulverized fuel as applied to boilers.

The writer has watched the development of pulverized fuel for boiler plants with considerable interest for a number of years. Pulverized fuel is no new development in the cement industry, but only within recent years has it been applied to boilers. In the early attempts that were made to use this fuel on boilers, great difficulty was experienced owing to the high furnace temperature that is usual in burning coal in this form. As a result these early installations all gave a great deal of trouble due to melting down of brickwork or other rapid deterioration of the furnace.

FURNACES of two 8,750-sq. ft. boilers converted to burn pulverized fuel. Pulverizing equipment and coal bins located directly above boilers. No conveyors or dryers are used. One operator handles both boiler and pulverizer. Furnaces are of the ventilated hollow-wall type, the cooling air being used as preheated excess in the combustion chamber.

As the ratings increased at which boilers are operated when stoker fired, we came to know more about the construction of furnaces for high temperatures. As the furnace temperature in any stoker-fired installation today approaches closely the temperature reached in the pulverized-coal furnaces, therefore, through the experiments that have been carried out with stoker-fired installations, means have been developed to aid in overcoming one of the principal troubles originally encountered in burning pulverized fuel under boilers.

The adoption of this fuel in boilers has always suffered by reason of the tendency of designers to transplant bodily to the boiler plant, pulverized-coal equipment as used in the cement and other industrial plants. Owing to essential differences in operating conditions it was found necessary to modify the methods as used in the cement plant considerably in order to operate successfully in boiler rooms.

After careful investigation of existing pulverized-fuel plants it was felt that it would be entirely practical to operate without drying the coal prior to the time that it goes to the pulverizing mill, provided proper precautions were taken in the design of the equipment. Under normal conditions the fuel that will be burned in the Rochester plant will be a Pittsburgh coal running between 5 and 8 per cent moisture. Under exceptional conditions this coal may be practically saturated with water, thus carrying as high a percentage of moisture as is possible for the coal to absorb.

During the periods of operation when the coal is carrying this high percentage of moisture, investigations have led us to the conclusion that the only part of the pulverizing coal system that will fail to function is the conveying equipment carrying the fuel from the point at which the pulverizers are located to the point at which it is to be burned. If such conveying system can be eliminated, the plant can be expected to continue in operation during the worst conditions of moisture. It is realized that the mills will lose in capacity and the burning of the coal will be less efficient. The loss in capacity can be overcome by designing the plant so that under normal conditions the mills will pulverize sufficient coal for 24 hours' operation of the boilers, if the mills are operated only 12 to 16 hours. The loss in efficiency in burning the coal is serious only from an economic viewpoint. As it is unlikely that these extreme conditions of moisture will continue for any great length of time in the course of the year, this loss in efficiency is not of serious consequence.

In designing the plant two fundamental requirements were laid down: First, that the plant must continue in operation and not close down under the most adverse conditions of moisture. During this period efficiency is of secondary importance. Second, during normal conditions the plant must operate at a high efficiency and be thoroughly reliable. The ability of the mill to pulverize moist coal and the rate at which the mill capacity decreases with increased moisture in the coal were, therefore, points of primary importance in the selection of the mill. The capacity of the mill under normal conditions is such that if it is operated approximately 16 hours a day, it will deliver sufficient pulverized coal to keep the boiler in operation continuously under the load conditon that the station will have to carry.

The plant was designed in such a way that all handling of the pulverized coal after it leaves the mill, other than delivery by a column of air to the cyclone separator, has been avoided, thus eliminating the one feature most likely to close down the plant.

In Fig. 1 is shown the general layout of the plant. The mill is located at what was the former floor level of the old bunker, approximately ten feet above the boiler. The bunker construction has been torn out entirely and raw-coal and pulverized-coal bins built in the space formerly occupied by the old bunker; considerable care has been exercised to insure that these bins will be self-cleaning. The feeders for the pulverized coal form the bottom of the pulverized-coal bin.

The coal is taken from the mill by an exhauster and delivered to the cyclone separator from which the air again returns to the mill. A motor with an extended shaft is used for driving the mill and the exhauster, thereby decreasing somewhat the total motor horsepower below that which would be required for separate

motors. From the feeder the coal is delivered through pipes down to the burner at the boiler.

No dryers are installed for the reason already given. Some recent experiments carried on in the pulverization of wet coal indicate a considerable loss of moisture in the coal in passing through the mill. There is a possibility that under the worst conditions it would be necessary for the operator to clean the mill once or twice a shift. Provisions are being made, however, for doing this quickly and at a minimum of inconvenience to the operator. Care is taken in the design of the pulverized-coal bin to keep wet coal from arching over the feeder, or in case it does arch, a means of agitating the pulverized coal will be provided.

This design eliminates certain features previously considered an essential part of a pulverized-fuel plant and reduces it to its simplest elements. Simplicity and ease of operation have been carefully considered in making the layout. The physical relationship of the mill and the boiler is such that under normal operating conditions one man can oversee both the mill and the boiler. It is believed that this will result in a decided economy in operation, as compared with pulverized-fuel plants in which the pulverizing is done in a building entirely separate from the boiler room and operated by a separate crew. With this layout the same man can take care of both jobs, and only in an emergency will he require additional help. This means practically

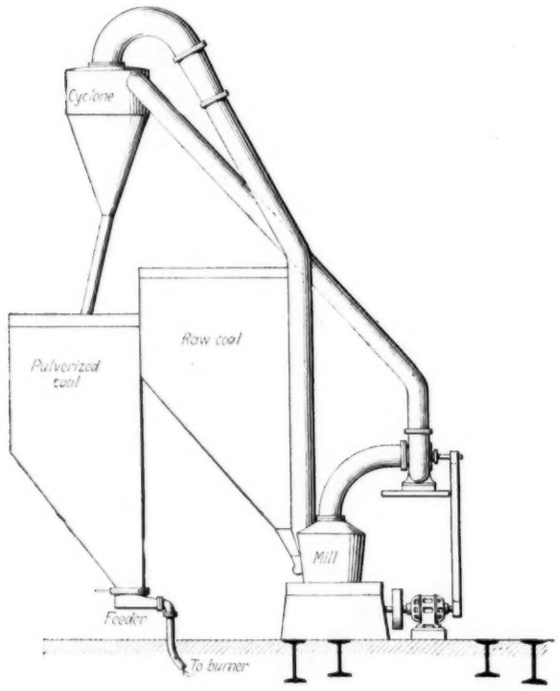


FIG. 1—GENERAL LAYOUT OF PREPARATION PLANT

that the number of mill operators required can be cut to a minimum, one man thus being able to take care of a large number of mills. This mill operator would be required to give attention to the mill only when it would be shut down by the boiler operator owing to some emergency. With considerable storage of pulverized coal between the mill and the boiler, a shutdown of the mill for a reasonable length of time is of no serious consequence, and this fact simplifies the requirements placed upon the mill operator.

The furnace for these boilers extends from a point about six feet below the top of the boiler to the level of the economizer floor under the boiler, giving a total furnace height outside of about 32 ft. Special care has been given the design of this furnace, which has been complicated due to space requirements imposed by the old building construction, but by changing the location of some of the equipment on the economizer

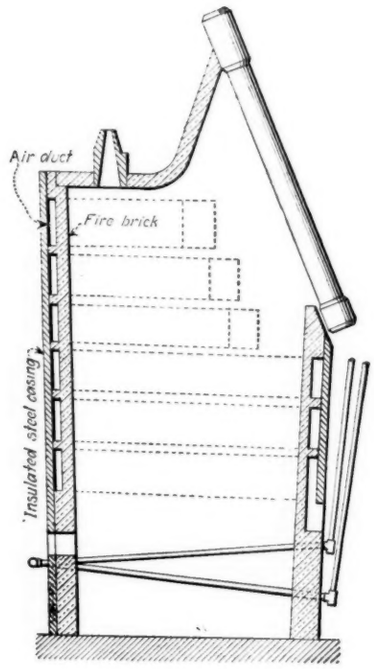


FIG. 2—SECTION OF FURNACE SHOWING WALL CONSTRUCTION

floor it has been possible to design a furnace that will give at least 300 per cent rating continuously.

The furnace is of the hollow-wall, air-cooled type, a section of which is shown in Fig. 2. The inner wall is built up of firebrick laid principally in header courses, giving a wall thickness of nine inches. An air space is then left all the way around the furnace, and an insulated steel casing is built around the firebrick construction. All the secondary air required for combustion is passed through the hollow space between the firebrick wall and the steel insulated construction, so that it is preheated before entering the furnace. This hollow space between the two walls is divided into horizontal strata by means of fire tile forming an integral part of the furnace wall and extending out to the steel casing. There will be seven of these spaces, each being provided with its own damper, so that the amount of air taken into the furnace at any point can be controlled. The flat suspended arch at the top will likewise be air cooled, the heated air from this source being introduced around the burners. The bottom of the furnace is similarly built with an air chamber, the air passing through this chamber being supplied to the pressure fan which delivers this heated air to the pulverized-coal feeders.

This furnace is, therefore, jacketed on all sides with air which is afterward used in the combustion chamber, and it is believed that this will result in a considerable reduction in radiation loss and somewhat increased efficiency in combustion due to preheating of the air.

The outer steel casing of the furnace is designed to carry the load of the inner firebrick furnace wall. These inner walls are all inclined outwardly in the vertical plane and are, in addition, all built as horizontal arches, giving them an initial bow outwardly. By means of the tile that form the horizontal divisions between the different air zones, the outward thrust of the firebrick walls is carried through to the inner surface of the insulated steel casing. Care was taken in the design to hold these inner walls in such a way that the expansion of the firebrick will force the wall outwardly rather than inwardly.

The steel casing construction consists of ¼-in. steel plate on the outside, then two layers of 1½-in. eighty-five per cent magnesia blocks, all laid so as to split joints, and a 1-in. layer of fire felt faced with ¼ in. of high-temperature cement pressed to a fine, dense surface; this surface is capable of withstanding a temperature of 2,000 deg. or somewhat higher, which it is believed will be ample to take care of the radiation from the inner furnace wall.

One novel feature in the design of this steel casing is that it is built in sections, each section being removable. These sections are bolted to the buck stays by means of through bolts and clamps. The complete section, consisting of steel plate, magnesia block and fire felt, will be built up complete in the shop and simply put in place and bolted to the buck stays in the field. Peep-holes consisting of 2-in. pipe thimbles, flanged over at one end and provided with a locknut at the other, are installed at suitable intervals and also used to clamp the different layers of the section together.

Suspended Arch Construction

The suspended arch is designed to present an easily renewable firebrick face on the flame surface and an air passage between the two layers of firebrick which form the complete arch. The design is such that individual blocks or sections of the arch can be removed without disturbing the remainder of the arch, and the method of suspension is such that individual blocks are free to move in any direction to take care of contraction and expansion as it may occur with changing temperature in the furnace.

A Lopulco water screen is installed in the bottom of the furnace, the arrangement being such that the circulation is from the bottom drum of the *C* unit of the boiler to the top drum of the same unit. In the water screens 3½-in. tubes will be used with cast-steel connection boxes.

From the boiler the products of combustion pass to the economizer which is on the floor below the boiler. These economizers were originally installed in 1912 and are of the three-pass type. In order to make room for the large furnace volume required, it is necessary to remove one-third of this economizer. Tests made on the present economizer indicate, however, that considerably more than two-thirds of the total temperature drop in the flue gases through the economizer occur in the first two-thirds of the economizer and that, therefore, less than one-third of the effective work now being done by the economizer will be lost. It is believed that the actual loss will be between 15 and 25 per cent.

For handling the ash that is thrown down at the rear of the boiler, a vacuum system is contemplated. The ash from the bottom of the furnace will be dropped through into an ash cellar below, as will that which collects in the bottom of the economizer.

Keeping a Record of Plant Troubles

By Arthur D. Palmer

An important detail in the operation and maintenance of power-plant equipment is that of securing complete data on the cause of troubles and shutdowns and making proper reports for future reference.

During my experience as an inspector, when making investigations of accidents, I was surprised to find the number of engineers who did not understand the rudiments of making a clear investigation of troubles and the proper reporting of them.

It has been my opportunity to examine several hundred trouble reports, and I have been surprised at the absence of data relative to the causes and remedies of the troubles. In my opinion any average-sized plant should keep a record of all its accidents, with causes, remedies, data, etc., and the lost time occasioned by shutdowns due to accidents or other causes.

Too many engineers when operating a new machine, take for granted that if it does not work properly it is

DATE 10-12-22 TROUBLE CARD PAGE NO. 19
JOB NO. XX42
TROUBLE Bearing on governor end of No. 1 Turbine burned out
CAUSE Oil pipe plugged up
REMEDY New bearing lining installed
MEN USED 1. Murphy 2. Clark 3. 4.
MATERIAL USED one bearing lining
TIME MACHINE OUT OF SERVICE 4 hours
OTHER DEPT.'S EFFECTED BY TROUBLE None
WORK PERFORMED UNDER SUPERVISION OF Chief Engineer
SIGNED 4 P.M. 10-12-22 C.E.
REPORT OF THIS MATTER TURNED INTO OFFICE

ALL NECESSARY INFORMATION IS RECORDED ON THIS CARD

not up to them to get it running right. This was demonstrated in a certain case of a new pump installation to handle hot tar. A few weeks after the pump was installed, the engineer reported that the piston rod on the tar end had to be packed daily, and on this account the pump was condemned. An examination by the manufacturer's representative showed that a loose bushing had been slipped on the rod, leaving only sufficient space in the stuffing box for two rings of packing. The trouble reports made out in this case by the engineer read as follows: "No. 1 pump stuffing box on tar end leaks. Stuffing box should be made deeper. Don't know any cause for this condition. Work done—none." After the bushing was removed, no further trouble was had. If the engineer had done a little investigating, he would have found the trouble.

In my opinion nothing teaches a man the proper care and operation of mechanical equipment like the solution of trouble problems. For my own plant I have arranged a system of cards, a sample of which is shown in the illustration. The card is of convenient size to fit a loose-leaf book; it is made in duplicate, and one copy is sent to the office. On this card is recorded all the details relative to any trouble at the time it occurs. I have found the cards useful in instructing new men and informing them as to the troubles that are liable to be met with in the operation of the plant.

Increasing Engine Efficiency by Mixing Air with the Steam

FROM time to time the Engineering Experiment Station of the University of Illinois issues bulletins reporting important research work along engineering lines. The latest bulletin—No. 131, "A Study of Air-Steam Mixtures"—gives the results of a most

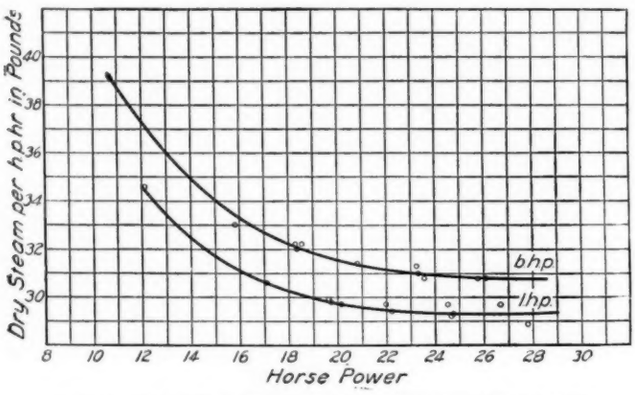


FIG. 1—WATER-RATE CURVES FOR STEAM ALONE

interesting series of experiments carried on by Leroy A. Wilson[1] and Charles Russ Richards.[2]

The outstanding conclusion from these experiments may be expressed as follows: "Under certain conditions (fully explained in the bulletin) given weights of steam and compressed air mixed and used in a single cylinder give considerably more power than the total produced by the same weights of steam and air acting in two separate cylinders of the same type." The main facts and theories covered in this 96-page bulletin are outlined in the following digest:

Equipment Used in Tests

Three general sets of tests were made using, respectively, steam alone, air alone, and steam-air mixtures. All the tests were made with an 8x18-in. Murray Iron Works engine having a builder's rating of 24 i.hp. when operated non-condensing at 100 r.p.m. with an initial steam pressure of 100 lb. gage. This engine had a head-end clearance of 5.48 per cent and a crank-end clearance of 5.63 per cent of the piston displacement.

A Prony brake and indicators were provided for measuring the brake and indicated horsepower. Other accessories included a 100-sq.ft. surface condenser (without a vacuum pump) to permit measurement of the exhaust steam, an air compressor, an air heater, a chamber for mixing air and steam, a venturi meter for air measurement, a thermometer to measure the temperature of the saturated air entering the heater and inlet and exhaust thermometers on the engine.

The tests with steam alone were made to find the water rate at various loads when using saturated steam at 100 lb. gage and exhausting at practically atmospheric pressure. Fig. 1 gives the water-rate curves for the engine using steam alone.

The tests with air alone were, like those with steam, made with an initial pressure of 100 lb. gage and an exhaust pressure of practically zero gage. These tests were more extensive than those made with steam, on account of the necessity of obtaining water-rate curves for initial air temperatures of 100, 200, 300 and 400 deg. F. During the air tests the condenser was disconnected and the exhaust passed directly into the room. On all the tests with air (except those with inlet temperatures above 300 deg.) difficulty was experienced with frost and ice at the exhaust, the exhaust temperatures averaging about as follows:

Approximate Initial Temperature	Exhaust Temperature
100 deg. F.	—50 deg. F.
200 deg. F.	—5 deg. F.
300 deg. F.	+21 deg. F.
400 deg. F.	+42 deg. F.

The air consumption per indicated horsepower at various loads and initial temperatures is plotted in Fig. 2, the brake-horsepower curves being omitted for lack of space.

In the tests with steam-air mixtures, a measured amount of air at 100 lb. gage pressure and known temperature was mixed with a measured amount of saturated steam at the same pressure. The temperature and pressure of the mixture were read at the point where

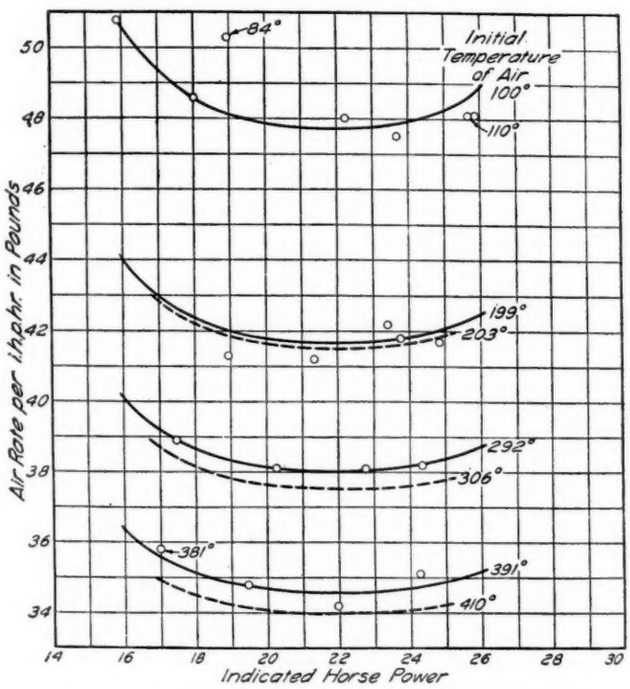


FIG. 2—AIR CONSUMPTION PER I.H.P.-HOUR FOR ENGINE USING AIR ALONE

the mixing chamber discharged to the engine throttle valve. In these tests the exhaust passed to the condensers, where all the steam condensed except the small amount carried through by the saturated air. The net weight of steam used per hour was found by adding to the weight of condensate the computed weight of water carried off in the discharge air and the small amount trapped from the air-steam mixing chamber. From this total was subtracted the computed weight

[1]Now professor of mechanical engineering at the Oklahoma Agricultural and Mechanical College.
[2]Now president of Lehigh University.

of moisture carried by the air entering the mixing chamber.

The method of figuring the gain in power due to mixing was as follows: From the previously plotted curves there was found the water rate of the engine when operating with steam alone at the same indicated horsepower as was developed in the steam-air test. This water rate was divided into the weight of steam used per hour in the steam-air test to get the amount of power that would have been developed by the steam alone. A similar procedure was followed for the air. By comparing the sum of these two indicated horsepowers with the actual indicated horsepower obtained with the mixture, the percentage of gain in power is easily figured. Figs. 3 and 4 give the results for initial air temperatures of 100 deg. and 410 deg. respectively. The original bulletin also gave curves for 203 and 306 deg., these lying between those for 100 deg. and 410 degrees.

Greatest Gain with 30 Per Cent Steam

The curves show that the maximum economy occurs with mixtures containing about 30 per cent of steam and 70 per cent of air. The gain is more pronounced when cold air, rather than air previously heated, is used. It is also greater for lower loads. The gain at the maximum load carried, with an initial air temperature of 410 deg. F. is 8 per cent, while the gain at approximately the same load with air at a temperature of 100 deg. F. is about 17 per cent. At three-quarters of the maximum load and with air supplied at a temperature of 100 deg. F. the gain is about 24 per cent. Tests at less than three-quarters of the maximum load carried were impracticable, because the pressures at the end of expansion were below the back pressure.

The increased efficiency seems to be due mainly to two causes, the first of which is a reduction in cylinder con-

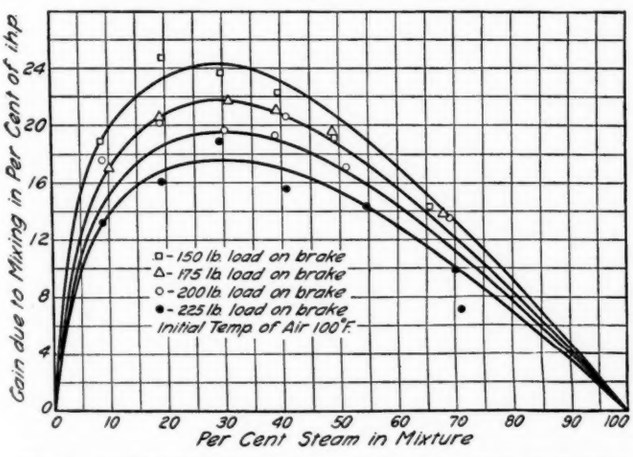


FIG. 3—PERCENTAGE GAIN IN I.H.P. BY USING MIXTURE WITH INITIAL AIR TEMPERATURE OF 100 DEG. F.

densation. Experiments made by Osborne Reynolds in 1873 showed that the transmission of heat from a steam-air mixture to metal walls was much slower than from steam alone. As the amount of air was increased, the transfer of heat was found to decrease until a certain ratio of air to steam by volume was obtained. After that there was little further reduction in heat transfer. The reduction in cylinder condensation is due not only to the fact that air is interposed between the steam and the cylinder walls, but also to the fact that the steam is automatically superheated by being mixed with air. For example, if saturated steam at 100 lb. pressure is mixed with air at the same temperature and pressure, the steam in the mixture will be superheated if the final pressure of the mixture is 100 lb. The reason is that the total pressure of 100 lb. in the mixture is the sum of the partial pressures of the air and the steam, so that the pressure of the steam in the mixture is considerably below 100 pounds.

A further explanation of the improvement in efficiency may be found in Rankin's statement that the

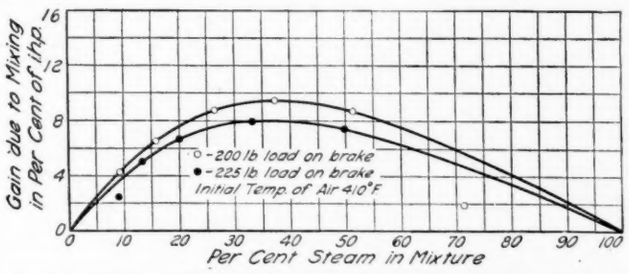


FIG. 4—PERCENTAGE GAIN IN I.H.P. BY USING MIXTURE WITH INITIAL AIR TEMPERATURE OF 410 DEG. F.

air has a tendency to increase the working temperature limits of the steam, independently of the addition of heat. The test data show this clearly, particularly for the exhaust temperature which is practically 212 deg. where steam is used alone, but considerably below 212 for the air-steam mixtures.[3]

Historical Appendix Describes Interesting Experiments

The following historical comments, abstracted from an appendix entitled "History of the Study of Air-Steam Mixtures," show that the idea of mixing air with steam is not a new one:

The value of air in preventing rapid condensation of steam was known by Savery and other scientists before 1800 and was utilized by them in the operation of water pumps by interposing a layer of air instead of a piston between the steam and the water.

In 1872 W. J. M. Rankine published an article in which he pointed out that air has a tendency to increase the efficiency of the mixture, independently of any addition of heat, by widening the working temperature limits of the steam.

In 1856 the Erie Railroad tried out a large locomotive in which the hot flue gases were injected under pressure into the engine cylinders. Owing to the bad effect of the ashes and intense heat on the cylinder walls of the engine, the test failed. The theoretical aspects of an engine of this design are interesting, and they indicate the efficiency that might be obtained if it were possible to overcome the practical operating difficulties. Similar experiments, using an oil-burning boiler, were started at the University of Illinois in 1905, but were not carried to completion.

Around 1870 the plan of providing a mixture by forcing high-temperature air into the boiler from coils of pipe in the hot flue was given a great deal of publicity. This plan, which originated with George Warsop, of England, came into commercial use on shipboard and apparently resulted in a noticeable saving of fuel. Since that time other experiments along this line have been tried with various degrees of success.

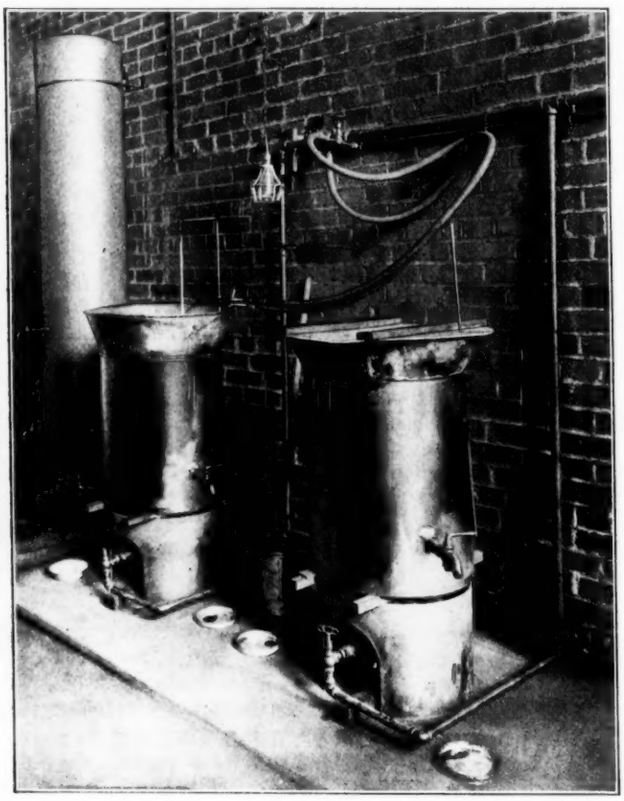
[3]The bulletin also contains an extensive discussion of the thermodynamics and general theory of air-steam mixtures. This is too technical to outline in the space available. It should be noted, however, that nine large diagrams are furnished with the bulletin. The first eight of these are total heat-entropy diagrams for air-steam mixtures of various proportions, while the ninth is a saturation chart for similar mixtures.

A Simple Method of Reclaiming Lubricating Oils

By G. A. Drysdale
Metallurgical Engineer, Midwest Engine Company

BUILDERS of both steam and internal-combustion engines use large quantities of lubricating oil while testing the engines. This oil, on becoming contaminated from use, is generally regarded as worthless. This is an inexcusable waste since the oil may be reclaimed and used again.

Our plant was confronted with the problem of what to do with this waste oil, and the metallurgical department was requested to devise ways and means to reclaim it. There were at that time over 60 barrels, or 3,000 gallons of used oil on hand, which on examination was found to be badly contaminated with water. The free



LUBRICATING OIL RECLAIMER

water was easily eliminated by settling and subsequent pumping out of the barrels, but the remaining oil still contained more or less water, lighter oils and foreign matter. The average analysis of this waste oil, as obtained from a number of samples, ran as follows:

Gravity, at 60 deg. F., Baumé	21 to 22
Flash point, deg. F.	154 to 220
Fire point, deg. F.	330 to 375
Specific viscosity at 120 deg. F.	2.90 to 3.50
Specific viscosity at 180 deg. F.	1.40 to 1.65
Water remaining in solution, per cent	5 to 10

The oil we were purchasing at the time was high grade, medium heavy, and gave the following analysis:

Gravity, at 60 deg. F., Baumé	21 to 23
Flash point, deg. F.	350 to 390
Fire point, deg. F.	422 to 456
Specific viscosity at 120 deg. F.	2.80 to 2.84

The instrument used to obtain viscosity was Scott's viscosimeter, a modified form of Engler's.

Two small tanks, of about twenty gallons capacity, were made of sheet steel and welded at the seams. One brass faucet was placed at the base of each tank, and a second brass faucet about 12 in. above the base, as shown in the illustration.

The contaminated oil was then placed in the tanks, filling them about three-fourths full, and illuminating gas with compressed air was supplied to the burners under the tanks for heating purposes. The temperature was raised slowly, as indicated by the thermometer with which each tank was supplied, suspended from the top and immersed in the oil.

When the used oil contained a high percentage of water, vigorous bumping and foaming, caused by the generation of steam, occurred, and it was necessary to raise the temperature more slowly. This foaming and bumping became apparent at 180 deg. F. and continued with more or less violence (according to the amount of water present) up to about 240 deg. F., at which temperature all the water had been eliminated and the oil became calm. The heat was continued until the oil in the tanks was brought up to 350 to 400 deg. F. and held at that temperature for three or four hours, with frequent agitation, then allowed to cool slowly. When cold, or at room temperature, the cooling taking about twelve hours, the reclaimed oil was drawn off at the upper faucet and the sludge removed by the lower faucet. A sample was obtained from each barrel of this oil for test purposes. A number of these samples gave the following figures:

Gravity, at 60 F	23
Flash point, deg. F.	350
Fire point, deg. F.	440
Specific viscosity at 120 deg. F.	3.00

Samples of oil were tested for grit, and in no instance was any foreign matter found. The oil was absolutely free of all lighter oils and of water. After reclaiming the oil was of a slightly darker color than that of the oil as purchased. This darker color was attributed to the presence of minute particles of free carbon, which in no way interfered with the oil passing through the smallest orifice in any engine oiling system. The oil was therefore passed by our inspectors, and each barrel, tagged with its analysis and marked "Reclaimed," was shipped to the testing department ready for use.

As the results obtained in this instance proved so satisfactory, we improved the working conditions and enlarged the capacity for production. Sufficient steam pipes were installed to enable a uniform temperature of from 75 deg. to 85 deg. to be maintained during the winter months, as this was found to be the most suitable temperature.

The economies of reclaiming are shown by the fact that the oil as purchased cost 75c. per gal. and the cost of reclaiming the same was approximately 10c. per gal. This latter cost included overhead expense, wages, etc. Up to date more than 14,000 gallons of lubricating oil have been reclaimed.

It was the custom during the war to use this reclaimed oil a second and third time before fortifying with new oil, but when the time came that lubricating oil could be obtained at a much lower cost, we established a practice of fortifying the reclaimed oil with new oil in the rate of two to one.

There are a number of oil reclaimers on the market today, each having its advantages, and naturally, the more expensive ones give the best results. Our equipment, although it may seem rather crude, gives satisfactory results and is a source of economy.

EDITORIALS

Spend More in Protection and Less on Repairs

IT USED to be thought that if a generator caught on fire, it was one of those unavoidable occurrences in power-plant operation that had to be accepted with the consequences. Now, however, it is known that this is not the case and that by proper design the difficulty can be overcome to a large degree. Breakdown in high-voltage high-speed generators cannot be avoided, but the damage due to an insulation failure can be greatly reduced by proper protection against internal trouble in the machine.

In cases of fires starting in these machines, dirt and grease on the windings have always been factors that contributed materially to the extent of the conflagrations. The volume of air passing through one of these large machines is so great that it is practically impossible to avoid dirt and grease entirely even by the best system of filtering and washing, when an open system of ventilation is used. A closed system of ventilation will go a long way toward keeping the windings clean. In case a fire gets started, provisions for introducing an inert gas into the ventilation system will not only mitigate the trouble but allow the machine to be taken out of service with minimum inconvenience to the station's operation.

These developments give favorable indication that another of the power-plant operator's nightmares is in a fair way of becoming only a memory. Of course such provisions involve considerable cost, but balanced against this are reduced cost of maintenance, increased output of the equipment, and less stand-by capacity required owing to greater reliability. The cost of some generator fires has made the expense of installing proper protection and fire prevention equipment look comparatively small.

Operating Instructions Essential to Reliable Operation

BROADLY speaking, the method of operation followed in hydro-electric plants may be classified under two widely different systems, one which requires that all operation be carried out in accordance with standardized instructions, that a determined effort be made to anticipate and prevent all abnormal operating conditions, and that equipment always be kept in first-class condition. Under the other system operation is carried out with little regard to any standard, little thought is devoted to the anticipation and prevention of abnormal conditions, equipment is allowed to deteriorate to a certain extent, and good luck is frequently depended on as an aid in maintaining service.

The first system, in effect, is followed in large, well-operated stations and offers the surest means of rendering that continuous, reliable service to which all consumers of electrical energy are properly entitled. Some stations operated under the second system make excellent operating records, but the ever present menace of some unexpected, but perhaps preventable, operating difficulty seriously crippling service from such stations makes the first system the only safe one to follow, if, as it should be, the rendering of perfect service is the goal aimed for. A very important aid toward efficient operation lies in the use of written instructions fully covering the operation and maintenance of hydro-electric equipment, and the article, "Operating Instructions for Hydro-Electric Plants," in this issue, deals with the preparation and use of that section covering operation.

In order to smooth the way for the inauguration of such a system as this, which requires the very rigid compliance with instructions, the first step should be to explain, preferably by means of rather informal lectures or by bulletins, the reasons that make it advisable to require that all operation be carried out in accordance with standardized instructions. Some of the reasons that may be emphasized are: greater safety to men and equipment, faster operation with less mental and physical strain, less possibility of the occurrence of mistakes, elimination of unsafe practices, and the satisfaction of knowing that operation is regularly carried out under those methods that experience has proved to be the best.

Turbo-Generators and Heat Balance

THE heat losses of the turbo-generators cannot be overlooked in heat-balance calculations in modern installations. In the first place there are the generator losses themselves, amounting to from five to seven per cent of the net output. Parsons in England proposes to recover the heat equivalent of these losses by placing pipes in the generator slots and circulating condensate through these pipes. In this country it has been proposed to place cooling coils under the generator frame and to pass the generator cooling air in a closed circuit over these coils which serve to cool the air. Condensate on its way from the condensate pump to the heaters would be circulated through these coils and thus most of the generator heat loss recovered. Such a system is now being installed at one of the newer central stations.

It is also becoming standard practice to run the bearing oil at temperatures around 120 degrees Fahrenheit and to use condensate in the oil-cooling coils. The heat removed from the oil is from one-half to one per cent of the power output on our largest units and proportionately larger on smaller sizes. It results from bearing and thrust friction and from conduction and radiation from shaft and casing at the high-pressure end. This heat is also recovered when the condensate is used in the oil cooler.

One will remark that these losses, amounting to from five and one-half to eight per cent of the electrical output, are small when the over-all station efficiency is considered. If an over-all thermal efficiency of seventeen per cent is taken for the station, it will be seen that

the recovery of these heat losses would decrease the total fuel consumption by one per cent, which is an appreciable saving in a large plant, particularly when such recovery does not require much additional equipment, nor does it increase operating expenses to any appreciable extent. Engineers are rapidly realizing that the valuable product of a boiler plant is the heat theoretically available for work when expanded from boiler pressure to the lowest advisable exhaust pressure. The use of bleeder heaters for the condensate from one or more of the low-pressure stages of the turbine is increasing rapidly and adds appreciably to the commercial efficiency of the whole station. The condensate leaving the oil cooler circulates through these bleeder heaters in series on its way to the boiler. External feed-water heaters and deaërators may or may not be used. It will be apparent from the foregoing that the turbo-generator itself can have a very noticeable effect on the station heat balance.

The Air-Steam Engine

THE engineer who likes, now and then, to give a little thought to problems lying outside the circle of his daily routine, may find the air-steam engine of interest. This apparatus, which has been popping up in various guises for the last hundred years, is again brought into the limelight by a series of experiments recently conducted at the Engineering Experiment Station of the University of Illinois. A digest of the bulletin describing this work appears on page 848 of this issue.

The upshot of the whole matter is that a mixture of compressed air and steam gives considerable more power than the total produced by the same weights of air and steam used separately. The conditions under which this statement applies may be briefly outlined as follows: Compressed air and steam at the same pressure are passed continually into a mixing chamber, from which the mixture goes to the engine at a pressure practically equal to that of the original constituents. The total indicated horsepower is then compared with that which would have been generated by the steam and air used separately.

In figuring how much power would be produced by the steam alone, the University of Illinois experimenters divided the actual weight of steam used by the water rate for steam alone at an indicated horsepower equal to the total generated by the air-steam engine. The horsepower for air alone was computed in a similar manner. On this eminently fair basis, the mixture showed a gain ranging up to 25 per cent. The greatest percentage of gain came with the lowest air temperature and with mixtures containing from 30 to 40 per cent of steam.

The original bulletin suggests various explanations of this gain, and these are briefly outlined in the digest. Here it is more important to consider the commercial possibilities of engines operated by air-steam mixtures. This is a subject where it is easy to jump to the wrong conclusion. If the mixture of air and steam gives more power than the same air and steam separately, it might seem a foregone conclusion that it would pay to mix them. This might be true if the choice were only between the mixture of air and steam and the same weights of air and steam used separately. There are, however, two other choices—air alone and steam alone. Compressed air must usually be generated from steam with a considerable loss of energy. In addition a large allowance must be made for investment and operating charges. Since the greatest gain in power comes with mixtures that are about two-thirds air and one-third steam, it would seem that the chief practical application of this method would be limited to cases where special circumstances make air an economically possible source of power. Under such conditions it might pay to inject a little steam into the air.

Aside from the relatively high initial cost of compressed-air energy, there are other difficulties of importance. For one thing, it would hardly be practicable to carry a vacuum with steam-air mixtures, on account of the enormous volume of air to be removed by the vacuum pumps. Even if this difficulty could be economically solved, the condensate, saturated with air, would be a serious cause of corrosion. Still another difficulty, found even when operating non-condensing, would be the formation of frost and ice in the exhaust. This, however, could be overcome by preheating the air to about 300 deg. F. While it would be rash to say that air-steam mixtures will have no major application in the future of power generation, it is at present hard to conceive of commercial applications for this method of operation.

A heat unit in the coal pile costs a certain amount that is easily figured. A heat unit on the grate costs more, on account of the cost of firing. It is also evident that a heat unit must cost still more at the steam nozzle than on the grate. If the boiler efficiency is 70 per cent, it might seem at first sight that the cost of a heat unit at the steam nozzle would be equal to the cost of a heat unit on the grate divided by 0.7. As a matter of fact, it would be more than this, because the operation of the boiler entails not only a heat loss, but also an important overhead charge due to interest and depreciation on the cost of the boiler and its auxiliaries, the building to house them and the ground upon which they stand, as well as the cost of supervision and other expenses. These, taken altogether, come to a considerable total. So the value of a heat unit keeps going up as it reaches a more and more refined form. These facts should be kept in mind when figuring the loss due to steam leaks, radiation from uncovered pipes, etc. When 13,000 B.t.u. is wasted on account of a faulty flange gasket, it may easily cost the plant twice as much as if one pound of 13,000-B.t.u. coal had been dumped into the river.

Among those close to the coal situation there is a feeling that the Federal Coal Commission is not receiving the co-operation it deserves from either the operators or the miners, and that both sides are indulging in a lot of stock comment without offering anything constructive. If this policy should persist to the point of defeating the real purpose for which the coal commission was created, the coal industry and workers will have to reckon with the temper of the American public.

According to the "Survey of Current Business" issued by the Department of Commerce, production is now back to 1920 levels, the increase being especially noticeable in the basic commodities. This announcement justifies the increased power demand as noted in last week's issue.

If the coming Power Show in New York meets expectation, and there is every indication that it will, its influence will assure its becoming an annual affair.

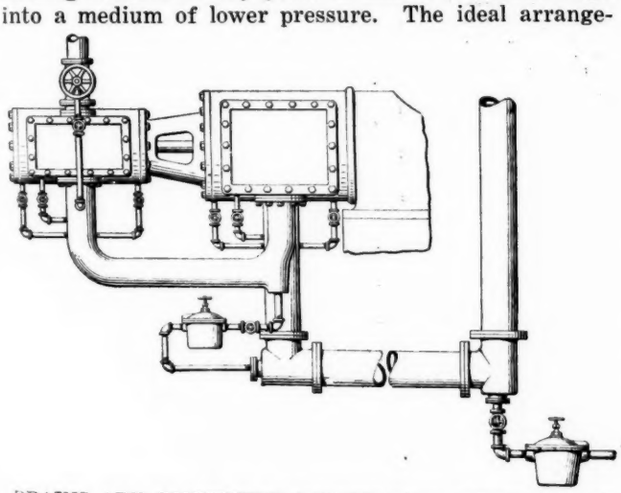
PRACTICAL IDEAS from PRACTICAL MEN

Practical Method of Connecting Cylinder Drains

The obvious reason for attaching cylinder cocks on steam engines and pumps is to allow the discharge of any water that may be carried over with the steam as well as any condensation that may take place during expansion.

Whether these drains function and to what extent is in many cases problematical. The work of connecting them is often left to the steam fitter during the construction of the plant, and when finished it is not a practical job from an operating point of view.

The fundamental principle to be kept in mind in connecting a drain at any point is that it must discharge into a medium of lower pressure. The ideal arrangement is found on locomotives, where each cylinder drain discharges directly to the atmosphere and the cylinder can be cleared of water in the shortest possible time without undue waste of steam.



DRAINS ARE CONNECTED DIRECTLY TO RECEIVER AND TO MAIN EXHAUST

It is not uncommon in stationary practice to find the drains from both cylinders, steam chests and throttle of compound engines, all connected into a single pipe without any increase in the size of the pipe. In such cases it would appear to be difficult to drain the cylinders on account of the higher pressures that might exist in the drain pipe than in the part to be drained, and the water would tend to pass from one end of the cylinder to the other.

A practical arrangement in piping the drains of a compound engine is shown in the illustration. The drains from the throttle valve, high-pressure steam chest, and cylinder are connected independently into the receiver, and the low-pressure drains are likewise connected into the exhaust line, it being immaterial whether the engine operates condensing or non-condensing, as the pressure will always be below that of the cylinder.

A certain amount of water will collect in the receiver, which should be trapped and discharged into the main exhaust; the point at which the main exhaust line should be drained depends largely on the plant layout, but in general a drain should be taken off at the lowest point and before the pipes assume a vertical direction this drain can be trapped or discharged directly to the heater. The layout here shown also presents a neat arrangement and eliminates unnecessary piping.

Chicago, Ill. JULIUS BRODSKY.

Is Too Much Expected of the Engineer?

The axiom that an engineer should not be compelled to leave the engine room to serve as a handy man around the plant was well illustrated in the following incident:

The writer was working during vacation period at a sawmill where no regular repair men were employed. The engineer, sawyer, superintendent or whoever was the handiest, did the repair work. A slab conveyor chain came off the drive pulley and the engineer with others was attempting to replace it with the machinery running. Suddenly, it was noticed that the machines were speeding up and the mill was beginning to vibrate. Apparently, however, no one was alarmed except myself. I immediately ran down to the engine room, arriving in time to see a can of cylinder oil thrown off the steam chest by the vibration. I closed the throttle valve, opened the cylinder cocks and notified the engineer.

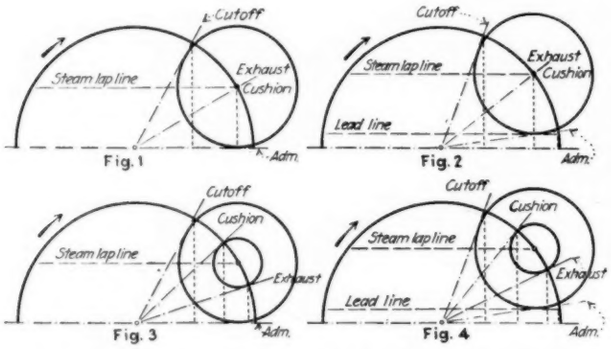
The engine, which was of reliable make and about 125 hp., was fitted with an automatic shaft governor. A setscrew had slacked off, which allowed a pin holding the eccentric disk to fall out, and steam was being admitted to the cylinder for practically full stroke. All that saved the engine from reaching a dangerous speed was the fact that it was heavily overloaded and it took some time to accelerate. This gave me a chance to reach the throttle valve. The next time the chain came off the engineer did not leave the engine room.

Pittsburgh, Pa. W. A. ANDERSON.

The Bilgram Slide-Valve Diagram

Among the various methods of showing diagrammatically the relative positions of piston and slide valve and the occurrences in cylinder and valve chest, is the diagram developed long ago by Hugo Bilgram, of gear-planing fame. In the cut shown it is used to illustrate four different sets of conditions.

Referring to Fig. 1, the diameter of the semicircle represents the valve travel on one scale and the piston



FIGS. 1 TO 4—APPLICATION OF THE BILGRAM DIAGRAM SHOWING RELATIVE POSITIONS OF PISTON AND VALVE

Fig. 1 shows relative positions for a D valve without lead or exhaust lap, Fig. 2 with lead but no exhaust lap, Fig. 3 with exhaust lap but no lead, and Fig. 4 with exhaust lap and lead.

stroke on another, the arc representing the crankpin path; and where there is no rocker with unequal arms, it represents the eccentric path also. The radius of the large circle is the steam lap on the valve-travel scale; then the tangents thereto indicate the crank position at cutoff; and where the line passing through its center cuts the semicircle is the exhaust point at one end of the stroke and beginning of compression at the other.

In Fig. 2 we get lead, as indicated by the height of the lead line above the semicircle diameter. This simply moves exhaust, cushion and cutoff ahead by the angle shown.

In Fig. 3 we introduce exhaust lap, represented by the radius of the small circle centered on the steam-lap line. Tangents thereto cut the valve circle at points corresponding to exhaust on the out stroke and cushion on the return.

Fig. 4 introduces the complication of both lead and exhaust lap. The exhaust-lap circle is centered as before on the steam-lap line, concentric with the steam-lap circle.

Perpendiculars dropped from the various points in the crankpin (or valve) circle give the corresponding piston positions.

ROBERT GRIMSHAW.

New York City.

An Unusual Accident with Heating Torch

We have used for a number of years at one of our shops a large kerosene heating torch. It was connected by a short pipe to a cylindrical steel tank of about 15 gallons capacity, equipped with a pressure gage and a hand-operated air pump for creating a pressure of air in the space above the oil, this being necessary for the operation of the torch.

After several years' use the hand pump was discarded and the air was supplied by connecting up the tank by means of a hose to the compressed-air supply system of the shop, this being much easier and quicker than the old hand pump. From time to time the men were warned not to let the pressure in the tank exceed fifty pounds.

Recently, one of the men was using this torch and had shut off the air pressure at the supply valve after admitting sufficient air to the tank, but did not take the precaution to disconnect the hose. After using the torch for some time, he had just shut off the supply of oil to the torch and was still in a stooping position, when the tank burst, throwing him violently against a machine, knocking him unconscious and completely saturating him with oil. Had the flame from the torch not been shut off just at the time it was, this man's hair and clothing would undoubtedly have taken fire with serious if not fatal results.

After the accident it was found that the supply valve was leaking slightly, and no doubt the pressure in the tank was well up to that of the supply system of 100 lb. when the tank burst. Previous to the accident no one about the shop regarded the torch as dangerous to life.

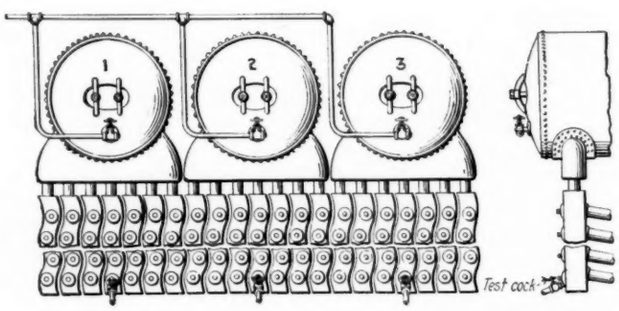
Springfield, Ohio. F. J. FOOTE,
Supt., I. C. & E. Traction Co.

Controlling Density of Boiler Water

In the operation of our boiler plant it was noticed that the majority of tube renewals occurred under the No. 3 drum, or the one farthest from the end at which the feed water entered. This discovery suggested the possibility of the existence of various water densities and degrees of salinity.

In order to determine the actual salinities of the water in each of the three drums, ¼-in. test cocks were installed by drilling through a tube cap at the bottom of the header under each drum. Samples of the water were then taken from each test cock at regular intervals and the density of the water in each drum determined.

The tests made showed that the salt content in the three drums varied from about 125 parts per 1,000 in No. 1 drum to 500 parts in No. 3. This was concluded



AMOUNT OF BLOWDOWN IS DETERMINED FROM TESTS MADE OF WATER IN EACH DRUM

to be the cause of the excessive number of tube renewals under No. 3 drum. It also indicated that the circulation was such that the water in No. 1 drum was always the freshest of the three. Consequently, tests were made of the water from each drum in each boiler every day, and the quantity of water blown from each was determined by the salt content. In other words, as a result of these tests a routine schedule of blowing-off was adopted whereby the water was kept fresh in all the drums. Since this schedule has been in operation the tube renewals have been practically nil.

Crockett, Calif. CLAUDE BROWN.

Safety First in Power Plants

Much has been written concerning the necessity for guards around saws and planers, railings to prevent people from becoming entangled in revolving wheels, and signs to give warning of danger in various other places, but the idea of avoiding accidents in the steam plant seems to receive little attention. The following suggestions should be of value along this line.

It was the source of much satisfaction when the factory inspector recently visited a certain engine room and carefully examined the machines and the means adopted for keeping employees and others from being injured, and reported to the office that every precaution had been taken. This fact seems to warrant a description of the plan adopted. In the plant referred to there is one flywheel 10 ft. in diameter, which revolves at 100 r.p.m. A two-pipe railing prevents visitors from getting close to the wheel or the valve gear of this engine. It is frequently necessary for the engineer to go between the wheel and the engine frame, but a railing close to it affords ample protection. An 85-kw. generator is driven from this wheel by a 20-in. double leather belt, both of which are rendered safe by suitable railing.

The generator end of a 50-kw. unit is guarded in the same manner. The flywheel on this machine revolves at 275 r.p.m., and employees must frequently pass through a narrow space between it and a brick wall. An ordinary pipe railing is not sufficient at this point. Instead a skeleton frame made of 1¼-in. iron pipe is used. The lower part is fastened to the floor by screws through flanges, and the upper part is secured to the brick wall by long bolts that pass entirely through it, with washers and nuts on the other side. Expansion screws, which are supposed to be anchored within the wall, are not considered safe for such a place. This frame is covered by sheet iron, firmly bolted to the posts. The flywheel runs one-half inch from this sheet, hence it must be removed if the governor (which is in this wheel) needs adjustment or repairs.

Whenever a belt crosses a passageway, so that employees and visitors must frequently pass under it, some provision should be made for catching the belt if it breaks or runs off the pulleys, but such a feature is frequently overlooked until an accident happens and someone is injured.

The engine in this plant is of the long stroke, open type, hence the crank is always in full view. It is necessary to know the condition of the crankpin. When feeling a crankpin with the engine running, the following rule should always be observed: Do not try to follow the course of its motion, but hold an open hand just beyond its extreme travel and allow the face of the pin, or the strap to brush over the fingers. When trying the crosshead, always let it touch the hand at its extreme travel. Never try to touch it at any other point. High-speed engines are sometimes inclosed so that it is not possible to feel the crankpin, but the two disks which form the center crank can be touched without danger, and this includes the ends of the crankpin. If these are completely inclosed in order to use a splash feed, this, of course, cannot be done.

Many accidents have happened to engineers and oilers when oiling the valve gears of Corliss and similar engines while in motion. It is not possible to install a guard of any kind to prevent these, as safety depends wholly on the skill and good judgment of the operator Never allow your attention to be taken from the work in hand, as failure to observe this simple rule causes a large majority of the accidents on this account.

The engineer of a certain plant was requested to shut down, as it was necessary to repair a large belt. He complied, and as soon as the flywheel stopped he hung a tag on the throttle valve, which reminded him that the engine was not to be started until he was notified. In all such cases the party who ordered the shutdown should give the signal for starting. Another might conclude that all was ready, without knowing all of the conditions.

Where electric transmission has been adopted, it is only necessary to pull one switch out to stop the machinery or put out the lights in a certain department. Care should be taken to know that the work is completed and the workmen are clear of the line before that switch is thrown. Haphazard methods should not be tolerated. Do not attempt to make even the slightest repairs to an electric circuit while the current is still on.

Sometimes a motor will run for a long time without special attention, with good results, but every one of them should be inspected at stated intervals. This may save large repair bills with loss of time due to the necessity for waiting until a motor can be rewound, or at least until it can be taken down and another one set and wired.

On one occasion I allowed a bearing in a planing mill, which was well supplied with grease, to run too long without a thorough cleaning and renewal of the grease. One day it flashed into a flame, which communicated to the building, and while prompt action of the fire department prevented serious loss, it taught me a practical lesson about grease lubrication.

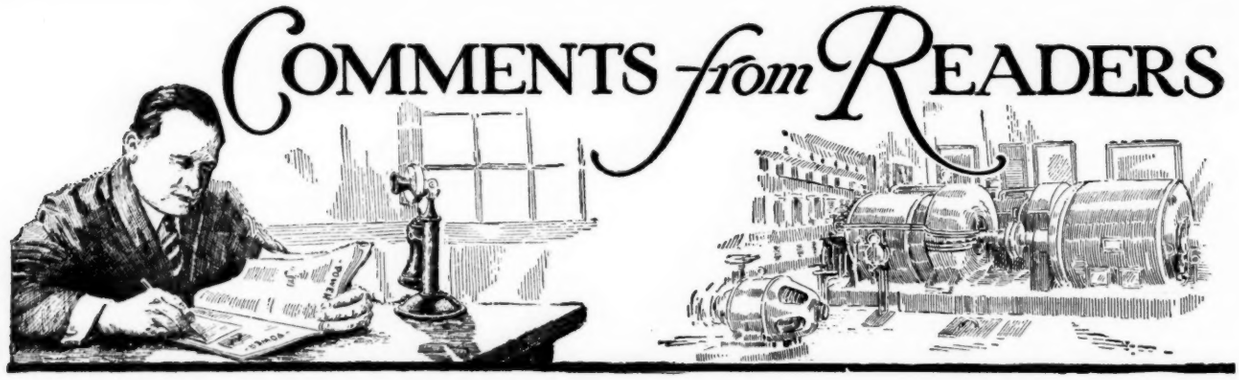
In another place a large shaft was fitted with cast-iron bearings which were adjusted to a close running fit. The oil cups had a central brass tube containing a piece of candlewicking. This seemed to waste oil on account of feeding too fast. Although this was on the safe side, I ignored this feature, and changed it until the feed was much reduced. The shaft did not heat, but continued to run at a normal temperature. One day the bearing seized the shaft and prevented it from turning properly. A slight change in the adjustment and more oil gave a safety-first result.

At the rear of one battery of boilers in my plant is a long narrow passageway with a doorway at one end for frequent use. If no further precaution had been taken in this case, it would make a man-trap if a pipe should burst under high pressure. In this passage are the blow-off valves and cocks, also the drip pipes from the main header, and water pipes for filling the boilers. As a matter of safety first, another doorway was cut in a division wall at the opposite end. This is seldom used, but whenever a man goes into this part, he must open this door and leave it open until he goes out. In case of accident he would not be trapped.

In this connection it is necessary to pass in front of a pop safety valve while walking on the edge of a boiler-setting wall. When a pop safety valve opens, the effect is startling in any case, and if this one should blow while a man was passing in front of it, he might be blown from the wall. To prevent this, a nipple was screwed into the valve, followed by an elbow looking upward. A small hole was bored in the lower part of the elbow to prevent water from collecting at this point.

W. H. WAKEMAN.

New Haven, Conn.



What Causes the Bearing to Heat?

Referring to the article by Mr. Wotring in the Nov. 14 issue, on "What Causes the Bearing to Heat," I think he is right in his assumption as to the probable cause of the trouble.

From the explanation given, it would appear that there is a circulation of eddy currents through the generator shaft and bearing, which, having a poor contact electrically, causes heating and may also cause pitting of the shaft or bearing if continued for any length of time. As eddy currents constitute a loss, the best way in which to eliminate it is to insert an insulator in its circuit to break it up, and that is best accomplished by inserting a piece of fiber between the pillar block and bedplate, as is done on rotary converters and motor-generator sets, being careful to insulate also the holding-down bolts with fiber tubes and washers. This, of course necessitates the lowering of the bearing to compensate for the thickness of insulation.

New York City. H. B. DROWNE.

Temperature Alone as a Measurement of Vacuum

Referring to the inquiry by W. W. B. in the Sept. 12 issue and to the comments in the Oct. 3 and Nov. 14 issues on using the temperature as a measure of vacuum, several years' experience in turbine test work cause me to think that whether temperature alone is a reliable measurement of vacuum depends largely upon where the thermometer bulb is placed, granted that the thermometer is accurate.

No doubt, if the thermometer correctly indicated the temperature of the exhaust steam, it would be a convenient means of measuring vacuum and also recording it, because a recording thermometer is more accurate and dependable than recording vacuum gages, and further, the vacuum record is of little value without a record of the barometer readings. One instrument takes the place of two.

The following factors influence the reading of the thermometer:

1. Condensed steam from the blading. If the thermometer is installed close up in the path of the water that leaves the last row of blades at high velocity, the readings will be too high, because this water is slightly hotter than the temperature corresponding to the vacuum.

2. Too close to equalizing pipes or other hot spots. On turbines that have equalizing pipes or cored passages that allow the steam that leaks past the dummy pistons or labyrinth packing to discharge into the exhaust, the thermometer should be installed so that the superheated steam will not influence the reading.

3. Thermometer bulb in dead air pocket. Air pockets may exist where the temperature is only a few degrees above that of the cooling water. Obviously, the reading will be far too low.

If the thermometer is installed in the current of steam so as not to be influenced by the conditions mentioned, it will give an accurate check on the mercury reading, and when any appreciable difference exists, the error will usually be found in the mercury gage and barometer readings. To measure vacuum accurately, good mercurial barometers should be had, but few plants have them. A good aneroid is the next thing, and it should be taken to the nearest testing laboratory or weather bureau and checked against the mercurial barometers there.

The weather bureau man takes the reading and refers it to a chart. The chart gives one or more corrections which include (a) instrument correction, (b) correction to 32 deg. mercury and scale temperature, (c) sea-level correction. He may or may not omit the last-named correction and whether he does or not will make considerable difference in the vacuum. Our steam tables for condenser work are based on 30-in. barometer at 58.4 deg. F. mercury temperature, which is the same atmospheric pressure as the standard 29.92-in. barometer at 32 deg. F. So the mercurial barometer reading should be corrected only for instrument errors and the resulting number converted to equivalent inches of mercury at 58.4 deg. F.

The aneroid should then be adjusted to that reading. Subtracting the mercurial vacuum-gage reading from the aneriod reading gives absolute pressure in inches of mercury. The correction from 32 to 58.4 deg. is nearly $\frac{1}{10}$ in., but the temperature correction from 58.4 to ordinary room temperatures may usually be neglected.

By using the method herein outlined, I have been able to check temperature readings with an error rarely over two degrees, and have always used a thermometer as a check on vacuum readings.

The energy in a pound quantity of steam available for a turbine to convert into kilowatts, increases very nearly in proportion to the decrease in exhaust-steam temperature and in the neighborhood of 28-in. vacuum is close to 1.5 B.t.u. per degree; 10 deg. change will change the steam consumption of the turbine 4 to 6 per cent, depending on the design, throttle-steam conditions and load. Exhaust-steam temperature is a direct measure of the loss or benefit that comes from a change of vacuum. J. R. BELKNAP.

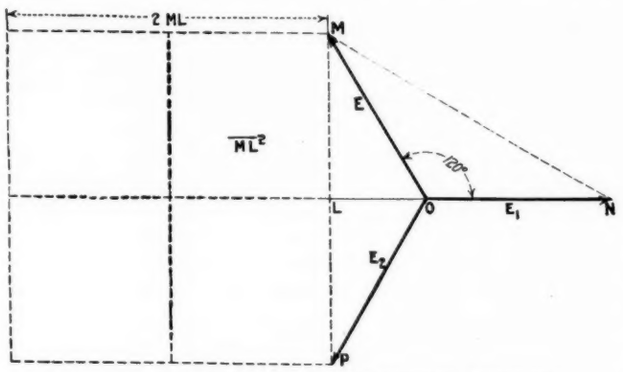
Lansing, Mich.

Power of a Three-Phase Circuit

Reading the explanation by L. M. Smith on page 621 of *Power* for Oct. 17, of the derivation of the factor $\sqrt{3}$ used in three-phase calculations, I thought of the many poor fellows who would be stumped by his off-hand declaration that "the relation between *MN* and its two components is expressed by the formula,

$$\overline{MN}^2 = E^2 + E_1^2 - 2\,(E_1\,E)\cos 120\ deg.$$

Most of them know that the square of the hypotenuse, or longest side, of a right-angled triangle is



SIMPLE METHOD OF DETERMINING LENGTH OF LINE MN

equal to the sum of the squares of the two other sides. They can all see that the length of the line *LO* is one-half that of *E*. Then, solving the right-angled triangle *MLO*,

$$\overline{LM}^2 = E^2 - \left(\frac{E}{2}\right)^2$$

E_1 is equal to *E*, *OL* equals $\frac{1}{2}$ of E_1 and $LN = 1\frac{1}{2}\,E$. Knowing this and the value of *LM*, just found, we can solve the right-angled triangle *MLN* for the value of *MN*.

$$\overline{MN}^2 = E^2 - \left(\frac{E}{2}\right)^2 + (1\tfrac{1}{2}\,E)^2$$

$$\overline{MN}^2 = E^2 - \tfrac{1}{4}\,E^2 + 2\tfrac{1}{4}\,E^2$$

$$\overline{MN}^2 = E^2 + 2\,E^2 = 3\,E^2$$

$$MN = \sqrt{3}\,E$$

Or, simpler yet, $MN = MP$ is twice as long as *ML*. If $\overline{ML}^2 = E^2 - \left(\frac{E}{2}\right)^2$, $2\,\overline{ML}^2$ would equal

$$4\left(E^2 - \left(\frac{E}{2}\right)^2\right) = 4\,E^2 - \frac{4\,E^2}{2^2} = 4E^2 - E^2 = 3E^2$$

and MP or $MN = \sqrt{3}\,E$.

RALPH LEONHARD.

Passaic, N. J.

Reducing the Boiler Pressure Quickly in Emergencies

In an article in the Nov. 14 issue Mr. Cultra describes a case where the boiler pressure was reduced by opening the safety valve after a fracture was discovered between the tubes in the bottom drum. In my opinion the method used in this case was not consistent with safety and good practice, because reducing the pressure suddenly by opening to the atmosphere is liable to cause a large amount of the water to evaporate instantly, and the steam would accumulate more rapidly than would be possible for it to escape, which would only tend to aggravate the existing danger; and explosions are liable to result from such practice, more especially in boilers where a large body of water is contained in one shell.

Although Mr. Cultra clearly indicates in his letter that he is aware of the dangers resulting from such practice, he advocates placing in some convenient place a valve large enough to relieve the pressure quickly in such emergencies.

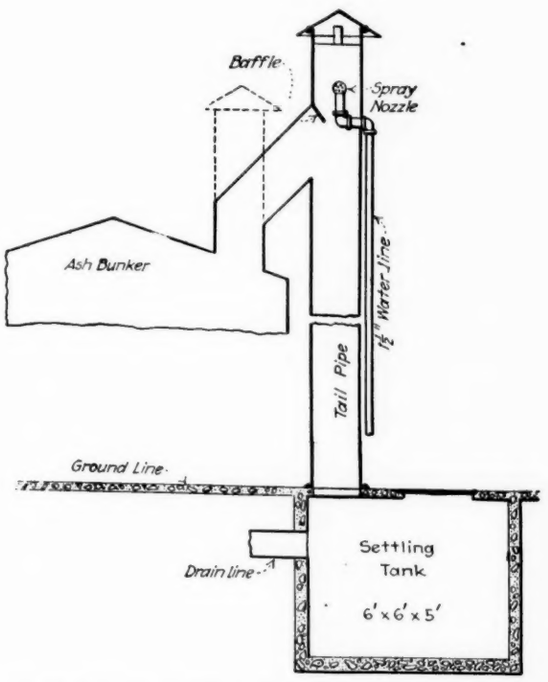
I believe that checking or pulling the fire and increasing the feed-water supply would relieve the pressure more quickly and would be much safer than bleeding to the atmosphere.

R. G. SPOONER.

New Bedford, Mass.

Eliminating Ash Dust with Jet Conveyors

I was interested in the inquiry of W. B. Trott in the Oct. 10 issue in regard to how to eliminate ash dust when using steam-jet conveyors, as I have recently experienced a similar condition. The sketch herewith illustrates a method of overcoming this trouble. The original vent indicated by the dotted lines was changed as shown and a water spray installed. Since I have found from experience that it requires a large amount



VENT IS FITTED WITH A SPRAY AND CONNECTS TO A SETTLING TANK

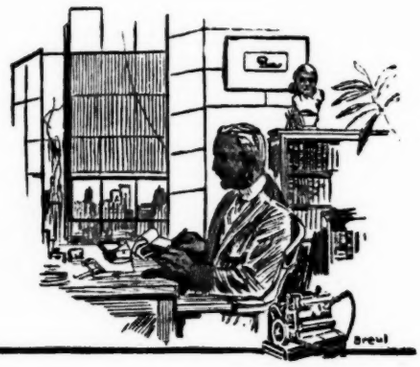
of water to carry the ash dust down, particularly when the ashes are hot, I would recommend that a 1½-in. spray nozzle with the pipe the same size be used, with a water pressure of 20 to 30 lb., or regulate the water valve to meet requirements. It is also advisable, where possible, to use waste water, such as condenser circulating water or from a well or brook, and pump it to the nozzle.

The settling tank allows the ash dust to settle so that the drain pipe will not be blocked up. The tank can be either iron or concrete and should be fitted with a clean-out door.

H. M. BASCOM.

Bridgeport, Conn.

QUESTIONS AND ANSWERS



Horsepower Required to Wind Up a Chain

A chain 300 ft. long hanging vertical weighs 2,000 lb. How many horsepower would be required to wind up this chain in one minute? S. S. S.

The number of foot-pounds of work performed would be the same as required for raising an equal weight through the same height as the center of weight of the chain would be raised, just as would be the case if in place of raising a chain of uniform weight per foot of length the work consisted in raising the center of gravity of a vertical rod of the same length and same weight per unit of length. The center of weight would be raised $300 \div 2 = 150$ ft., and neglecting friction of the winding drum, the work required would be $150 \times 2{,}000 = 300{,}000$ ft.-lb. As a horsepower is development of work at the rate of 33,000 ft.-lb. per minute, the horsepower, or average rate of work, would be $300{,}000 \div 33{,}000 = 9.09$ hp.

Relative Valve Settings with Single and Double Eccentrics

What is the difference in valve setting of a double-eccentric and a single-eccentric Corliss engine? P. C. V.

In a single-eccentric engine the steam and exhaust valves are operated from the same wristplate; the exhaust valves are set to have little or no lap when the writsplate is in central position; and to obtain early release after cutoff and compression of the exhaust, the eccentric is advanced ahead of the 90-degree position. This requires the steam valves to be set with lap when the wristplate is in the central position, for otherwise the advanced position of the eccentric would cause the valves to be opened with too much lead before the beginning of a stroke. In other words, there must be sufficient lap to counteract the advance of the eccentric made for accommodation of the exhaust valves.

As cutoff must occur before the wristplate has swung as far as it will go to one side or the other of the central position, and as this movement must be accomplished for 90-deg. revolution of the shaft, or practically one-half stroke, it follows that with steam admission occurring after the wristplate has passed the central position, the cutoff must occur earlier than one-half stroke. If it has not occurred, the steam valve will remain hooked up during the remainder of the stroke.

In a double-eccentric Corliss engine one eccentric is employed for operation of the steam valves and the other for operation of the exhaust valves. The exhaust valves and exhaust eccentric are set in the same manner as the eccentric and exhaust valves of a single-eccentric engine.

If the "steam eccentric" is set ahead of the crank, the same as the eccentric of the single-eccentric engine, the valves must have lap when the wristplate is in the central position to prevent too much lead, and cutoff would have to occur before half-stroke, just as in the single-eccentric engine. But by setting the eccentric without advance, the valves may be set without lap and cutoff may take place at any point from 0 to $\frac{1}{2}$ stroke.

By setting the eccentric with negative advance—that is, less than 90 deg. ahead of the crank—more than 90 deg. rotation of the shaft, and consequently more than one-half stroke, is accomplished before the wristplate is carried to the extreme position and thereby the cutoff may occur later than one-half stroke. But the wristplate is not brought to the central position until after the beginning of the stroke and therefore, if the valve is to be opened at the beginning of the stroke, it must have negative lap, that is, must be open when the wristplate comes up to the central position.

Closed Magnetic Circuit on Alternating Current

Why is it necessary to use a closed magnetic circuit for circuit breaker under-voltage releases when used on alternating-current circuits? J. B. R.

There are three reasons for using closed magnetic circuits on alternating-current magnets: To make the magnet operate as quietly as possible; to hold the magnet closed with a minimum of current in the coil; and to prevent stray magnetic fields. Unless all parts of the magnetic circuit of a magnet operating on an alternating-current circuit make an almost perfect contact, vibration will be set up due to the alternating pull on the parts, and serious noise will result. In fact, this has been one of the difficult problems in the design of alternating-current magnets, to get them to operate quietly.

The current in the coil of an alternating-current magnet is limited by two factors—the ohmic resistance of the coil and its inductance. The ohmic resistance is comparatively low and is practically constant except for temperature variations. When the magnetic circuit is open, there is a considerable air gap in the circuit, which results in a comparative low inductance in the coil and a large current to close the magnet.

When the magnet is closed, a complete magnetic circuit of iron is established, resulting in a low reluctance for this circuit, which required a small current in the coil to set up a strong magnetic field. The increase in the magnetic field increases the inductance in the coil and reduces the current to only a small part of that necessary to close the magnetic.

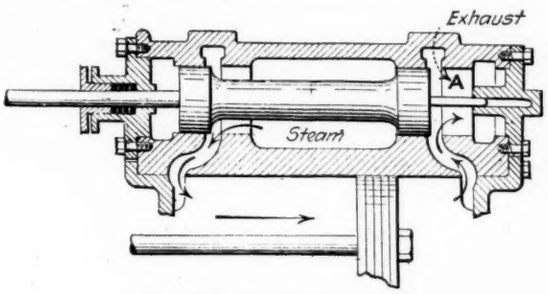
The third reason for using a closed magnetic circuit is to confine the lines of current to the magnetic circuit

only. If an air gap existed in the magnetic circuit, there would be a considerable stray alternating field which might induce eddy currents in other parts of the equipment that are cast solid and cause heating.

Indirect Piston Valve

What is an indirect piston valve for an engine and why is it so called? M. A. H.

An indirect valve is so designated because, for admission of steam at the beginning of a stroke, the valve is moved opposite to the direction of stroke of the piston. That is, to open the steam port the eccentric follows instead of leading the crank. The figure illustrates an indirect piston valve in which steam is taken beneath the valve while exhaust is taking place at the end *A* of the valve, thus reversing the method of steam distribution of the ordinary D-slide valve.



INDIRECT PISTON VALVE

Ammonia per Ton of Refrigeration

How can it be determined what amount of ammonia is necessary to be circulated per minute to produce one ton of refrigeration? W. L. S.

The weight of dry saturated gas that must be handled by the compressor per minute to produce one ton of refrigeration in 24 hours is

$$W = \frac{200}{H_2 - h_1}$$

W = Weight of ammonia handled per minute;
H_2 = Total heat in one pound of ammonia vapor at the coil pressure;
h_1 = Heat of the liquid at the receiver pressure;
200 = B.t.u. removed per minute to equal one ton of refrigeration in 24 hours.

For values H_2 and h_1 see table of properties of ammonia.

Example: Condenser or head pressure 198 lb. absolute; suction (evaporating) pressure 30 lb. absolute.

Then from a table of the "Properties of Ammonia" it is found that

H_2 = 538.5 B.t.u. at 30 lb. absolute;
h_1 = 71.6 B.t.u. at 198 lb. absolute, and

$$W = \frac{200}{538.5 - 71.6} = 0.43 \text{ lb.}$$

Since in figuring the compressor displacement per ton of refrigeration, the volume rather than pounds of ammonia is easier to use, the formula for weight can be changed to volume in cubic feet per minute by multiplying W, the weight obtained by the specific volume of one pound of ammonia at the suction pressure, assuming dry suction; this can be obtained from the ammonia tables. In the example given, the specific volume at 30 lb. absolute is 9.17 cu.ft. The piston displacement then becomes $9.17 \times 0.43 = 3.943$ cu.ft. per minute per ton.

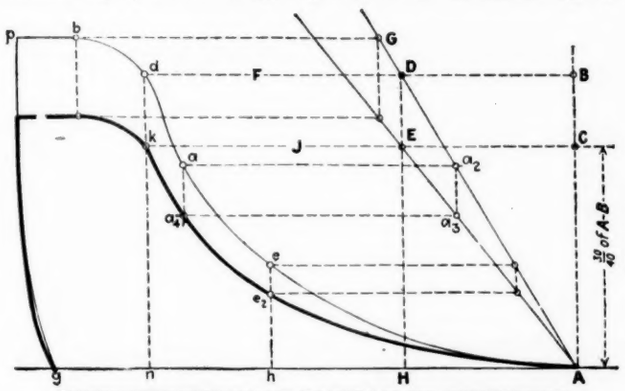
Volumetric efficiencies of compressors vary from 60 to 85 per cent, and in obtaining actual cylinder volumes this discrepancy must be taken into account. Builders guarantee 80 to 85 per cent volumetric efficiencies in machines of 50 tons capacity and over.

Reconstruction of Indicator Diagram to Different Spring Scale

How can the air-compressor diagram *pbeAg*, which was taken with a 30-lb. spring be reconstructed to show the diagram that would have been obtained had a 40-lb. spring been used in the indicator? A. L. C.

The reconstructed diagram would be of the same length as the original that was taken with a 30-lb. spring. Assuming that *gA* is the atmosphere line, the height *he* of any point like *e* of the original would be located on the reconstructed diagram at a point e_2 immediately under *e*, and the height he_2 should be $\frac{30}{40}$ of *he*. Any number of points of the original diagram can be transposed graphically as follows:

Draw *AB* perpendicular to *gA*. Set off any length, as for instance 2 in., on *AB* and set off $AC = \frac{30}{40}$ of *AB*. Through *B* and *C* draw the horizontals *BF* and *CJ*. At any convenient angle draw an oblique line *AG* intersecting *BF* at *D* and from *D* drop a perpendicular *DH* intersecting *CJ* at *E*. Then as *EH* like *CA* is $\frac{30}{40}$ of *HD*, a point *k* on the reconstructed diagram corresponding to *d* on the original would be found at the intersection of the perpendicular *dn* with the horizontal *JC*. To find a point corresponding to any other point like *a*, draw the line *AE* through *E*, then through *a* draw a horizontal line intersecting *AG* at a_1, drop the perpendicular a_2, a_3 and through a_3 draw the horizontal a_3, a_4.



RECONSTRUCTION OF DIAGRAM TO DIFFERENT SPRING SCALE

Then drop the perpendicular from a_4 and the point of intersection a_4 will be the point on the reconstructed diagram corresponding with the point *a* on the original diagram.

In the same manner, points of the reconstructed diagram corresponding to *b*, *e* and other points on the original diagram, can be located, and by thus finding a large number of points sufficiently close together, they may be connected to form a complete reconstructed diagram.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses.—Editor.]

Oil Engines for Village Power Plants

In an address before the Iowa section of the American Water-Works Association, George T. Prince, consulting engineer and former chief engineer Water-Works Department, Omaha, Neb., stated that he had been more and more impressed with the fact that many villages and small cities using steam-power plants were not able to meet maintenance and operating expenses. In numbers of instances the town had not been able to pay the coal bill, to say nothing of fixed charges and labor. Relief from this deplorable condition is in many instances being obtained through purchase of current for municipal purposes from transmission lines.

In Mr. Prince's opinion it would seem decidedly inadvisable, under present conditions, for towns of less than 10,000 population to install steam-driven power plants.

These small power plants use from seven to eight pounds of coal per kilowatt-hour. Assuming a thermal value of coal as 10,000 B.t.u., seven pounds will represent 70,000 heat units. It is apparent that such plants obtain a thermal efficiency of about 5 per cent. The Diesel engine will use approximately 8/10 pound of oil per kilowatt-hour, and assuming 20,000 heat units per pound of oil, the thermal efficiency of the oil-engine plant will be 21 per cent or over four times the steam efficiency. The latent heat of steam is largely responsible for this great loss; in large plants some of this latent energy is recovered, but very little in small plants.

Small Steam Plants Rendered Obsolete by High Cost of Coal

The installation of steam engines in municipal power plants was justified years ago, when coal was less than one-third of its present cost. Today it would be far better to discard the small steam plants which have been rendered obsolete by the high prices of coal and the economy made possible by the development of fuel-oil engines.

Mr. Prince cited a report he had received from the engineer of a water-works plant in a Western city of 25,000 population. This plant was operated by steam prior to 1915, but in that year was changed over to a Diesel plant. This letter stated that when steam-operated, the plant consumed from 3,400 to 4,000 pounds of coal per million gallons of water pumped, and additional power was purchased at 3½c. per kw.-hr. The comparative operating expenses were as follows:

3,804 lb. of coal at present prices in bin ($9.35 per ton)	$17.78
Estimated cost of lubricating oil	.50
Cost of 260 kw.-hr. purchased at 3.5 cents	9.10
Total cost per 1,000,000 gal.	$27.38
Present cost, using Diesel engines	6.93
Saving (equal to over 73 per cent)	$20.45

The engineer stated that these oil engines have been in continuous use since they were installed, except during periods of overhauling, and were considered practically as good as new. Since 1915 the city has installed two 520-hp. oil engines to supply electric current.

Among other plants changed to oil-engine drive, the speaker mentioned a particularly interesting case of a Kansas town that formerly operated a steam plant. About eleven years ago steam was replaced by oil drive, coal at that time costing $1.95 in the bin. Later, the city secured contracts with coal mines adjacent to the city limits for furnishing electric power for operating coal-mining machinery, and additional oil engines were installed. At that time the cost of coal in the bin was $3.05 and the cost of oil was 4¼c. per gallon in tank lots.

It was a very significant fact, so Mr. Prince felt, that oil drive was used with which to mine coal. If coal operators found it cheaper to buy electric current generated by oil engines, it is difficult to understand how towns situated at a distance could logically use steam power, having regard to the fact that the average small steam engine develops but 5 per cent thermal efficiency and fuel-oil engines from 21 to 33 per cent, dependent upon the load and type of engine employed.

Mr. Prince gave some tabulated data of economical results that can be obtained by the use of oil and steam engines. It was assumed that towns of 1,000, 2,500, 5,000 and 10,000 population were being supplied with power for furnishing electric lighting and pumping water at the following rate:

For 1,000 population	550 kw.-hr. per 24 hours
For 2,500 population	1,800 kw.-hr. per 24 hours
For 5,000 population	3,600 kw.-hr. per 24 hours
For 10,000 population	7,500 kw.-hr. per 24 hours

These assumptions may be at considerable variance with special cases, but they were based on information from various sources. It was believed that the unit costs given would fairly represent average results.

Having been in charge of steam plants for over thirty years and in two of the largest privately owned water plants in the country—Omaha and Denver—Mr. Prince stated that he fully appreciated all the advantages attached to steam-power plants, but was bound to recognize the benefits accruing through improvements in the art of generating power. He affirmed that it was his belief that oil engines in their present state of development were more economical in furnishing electrical power and pumping water for plants that serve communities of 10,000 or less, than steam or purchased power.

COST OF POWER

Population	Probable Annual Output in Kw.-Hr.	Cost of Power Plant Steam	Cost of Power Plant Oil	Annual Maintenance and Operating Exp. Steam	Annual Maintenance and Operating Exp. Oil	Unit Cost per Kw.-Hr. Steam	Unit Cost per Kw.-Hr. Oil
1,000	198,000	$35,300	$31,500	$13,874	$8,992	$0.070	$0.045
2,500	648,000	54,650	53,200	19,798	15,063	0.030	0.023
5,000	1,300,000	82,000	91,300	30,405	26,392	0.023	0.0204
10,000	2,700,000	117,500	103,000	49,348	39,303	0.0183	0.0146

Maintenance and operating expenses include labor, fuel and lubricating oil, repairs, 6 per cent interest on investment, depreciation based on 4 per cent sinking fund; life of oil engines assumed as 15 years, all other property 25 years.

Price of coal, $8.00 per ton for 1,000 and 2,500 population; hand-firing. Evaporation, 6-1.

Price of coal $7.50 for 5,000 population; mechanical stokers. Evaporation, 8-1.

Price of coal, $7.00 for 10,000 population, mechanical stokers. Evaporation, 8-1.

Price of fuel oil, 6 cents per gallon.

Price of lubricating oil, 60 cents per gallon.

Helical Gears Step Up the Speed of Water Turbines

With low speeds typical of water turbines and high speeds characteristic of generators, the helical gear forms a convenient link for transmitting power. Applications in Germany have made low-head water-power sites worth developing that formerly were commercially unavailable.

An account of vertical water turbines being geared to generators appears in the *Zeitschrift des Vereines*

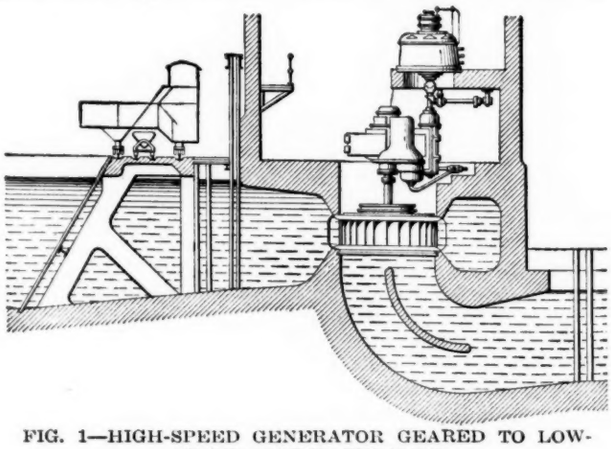


FIG. 1—HIGH-SPEED GENERATOR GEARED TO LOW-SPEED WATER TURBINE

Deutscher Ingenieure of July 22, 1922. The application of high-ratio helical-gear drives to step up the speeds of low- and medium-head hydraulic turbines, Fig. 1, makes it possible to select Francis turbines, running at 300 to 350 r.p.m., for driving standard high-speed generators.

The most favorable hydraulic construction is obtained with a vertical- shaft turbine for which a correctly shaped draft tube may readily be built. By surrounding the wheel with a spiral intake chamber, higher entrance velocities and

consequently, smaller gate areas will be permissible. A gain in operating economy as compared with that of horizontal shaft wheels of similar speed and capacity is realized. Other desirable features are the more convenient location of the governor and gate mechanism and the fact that the generator and operating-floor level are above the high-water mark, which eliminates expensive waterproofing.

Direct-connected slow-speed low-head turbines, operating at 50 to 75 r.p.m. require cumbersome and expensive gen-

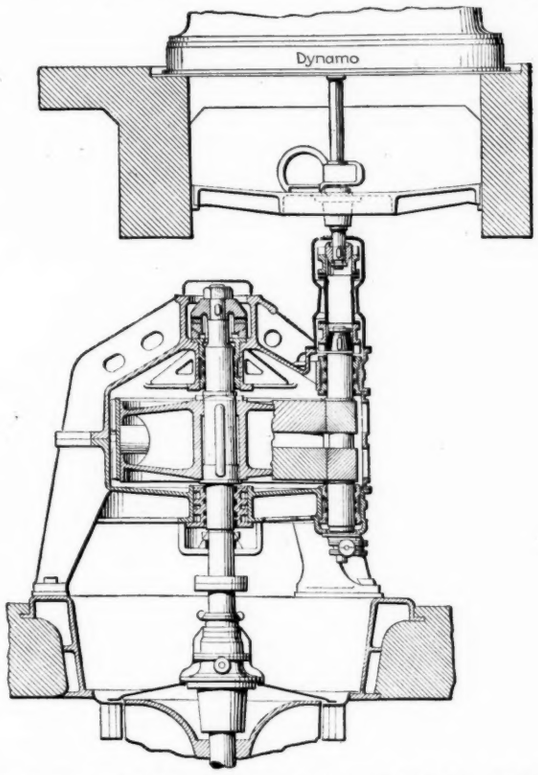


FIG. 2—TURBINE TYPE HELICAL GEARING EASILY UNCOUPLED AND REMOVED COMPLETE IN HOUSING

erators on a heavy foundation as well as larger shafts and more powerful overhead cranes for erection, than are necessary for geared units. The much lighter geared generator, therefore, offers the means of obtaining the maximum turbine economy without serious operating disadvantages. The gear housing should be made sufficiently heavy to support rigidly a guide bearing for resisting vibration and the heavy axial pressure of the water against the wheel. The same high grade of materials, accuracy in cutting and sci entific lubricating methods, characteristic of steam turbine gear drives, must be strictly adhered to.

Access to the turbine runner is afforded by uncoupling the gears and removing the housing containing them, without disturbing the generator.

A gear ratio of 1 to 10 or 1 to 12 will easily step up the normal operating speed of a 1,000-hp. turbine to drive a generator at 600 to 750 r.p.m. It is therefore advisable to select a turbine with the most efficient operating speed at the available head and to design the geared drive to step this up to the standard speed of the generator. The slight power loss in the gearing will be more than compensated for by the resulting higher over-all efficiency.

Fig. 2 shows a typical helical-gear drive with a turbine of 108 r.p.m. and a generator speed of 750 r.p.m. Three 1,300-hp. geared turbine units, with a speed increase from 70 to 750 r.p.m., are now in course of erection in the Ruhr district. Other similar installations are planned for south German projects. The possibility of developing many hitherto neglected, low-head hydraulic sites makes it highly probable that geared vertical turbine units in capacities up to 10,000 hp. will soon be in operation. The article does not state if any special steps are taken to prevent dampness from corroding the accurately cut teeth.

Naval Bureau of Engineering Tells How To Care for Boilers

The following instructions on "boiling out" and cleaning new or grease-fouled boilers are taken from Chapter 2—"Boilers"—of the Navy's "Manual of Engineering Instructions," which has recently been compiled and is now in the hands of the printer:

New boilers or boilers that have been fouled with grease or scale should be boiled out with a strong solution of Navy standard boiler compound and kerosene. The washing out of new boilers must be done thoroughly, as much scale is frequently found during the first six months after boilers are delivered to the government.

In boiling out the boiler the following method is considered best practice and shall be used: (1) Isolate the boiler by closing the steam stop, feed stop and check, surface and bottom blow valves. (2) Pour into the boiler about 5 gal. kerosene while the water is still at steaming level. (3) Run the boiler down slowly, thereby permitting the kerosene to cover thoroughly the surface of the tubes. (4) Close up the boiler and let it stand empty for a day or two, during which time the kerosene softens the scale. (5) To 100 to 200 gal. fresh water add boiler compound and kerosene in the proportion of 50 lb. compound and 5 gal. kerosene to each 1,000 gal. water in the boiler when the water is at steaming level. Pour the mixture into the boiler (half into each lower drum of express boilers). The 50 lb. of boiler compound to 1,000 gal. water should make the water slightly above 8 per cent normal alkaline strength, the amount considered necessary to remove scale and oily sediment. (6) Close the boiler. (7) Lead a steam hose from the auxiliary steam line and connect it to each bottom blow. (8) Turn on steam and bring the mixture to a boiling point, and let the pressure rise to 50 lb. gage. The steam will condense, causing the water level to rise gradually. As the water level rises, all the grease, mud and considerable scale will be loosened from the tubes and drums. The grease, etc., should be blown off through the surface blow to maintain the water level at approximately the surface blow level, blowing each time that the level has risen a couple of inches. Continue the blowing process for 12 hours. (9) Shut off the steam and allow the boiler to cool. (10) Remove the lower manhole plates (or handhole plates), drain out the boiler, and thoroughly air out. *Before sending men into the boiler, allow it to thoroughly air out and cool off, and secure all valves leading to boiler so that they cannot be opened accidentally.* (11) Clean the inside of the tubes and wire-brush the drums. (12) As soon as men can work in the boilers, wire-brush the drums and ends of all tubes. Clean the interior of all tubes, using approved style of boiler-tube cleaning brushes or wire rope. (13) Follow up the cleaning of all tubes by blowing them out thoroughly with a strong air jet. (14) Clean out all dirt. (15) Inspect carefully for signs of pitting, especially about the water line and near the projecting ends of the nipples and tubes. (16) Inspect elements for warping.

Kerosene Softens Calcium Sulphate

In boilers that use shore water to a great extent, as at shore plants, the water sides of the boiler may become incrusted with a thick coating of calcium sulphate scale. This scale is very hard and clings to the sides of the tubes and drums. Boiler compound does not attack this incrustation as readily as other varieties of scale. Kerosene, however, is very effective in softening this scale.

As an alternative, if kerosene is not readily obtainable, the boiler may be cleaned by filling it to steaming level with fresh water. For every 20 gal. of water in the boiler add 1 lb. of anhydrous sodium carbonate or 1¼ lb. of Navy standard boiler compound. Place in the steam drum about 10 lb. of zinc in the form of plates. Operate the boiler under light load for about 48 hours. Before beginning to boil out the boiler, note the alkaline strength of the water and maintain this strength during the entire boiling-out process by adding anhydrous sodium carbonate or Navy standard boiler compound.

After boiling out, allow the boiler to cool, remove the zinc plates, drain off the water and immediately begin to clean the tubes. The scale must be kept wet until removed. If allowed to dry, it hardens and is then very difficult to remove from the tubes and drums. After removing the scale, wash out the boiler with fresh water.

While boiling out, careful inspection should be made for leaky tubes, joints, seams and rivets. Any which develop, along with those known to exist, should be repaired.

News in the Field of Power

Proposes Laundered Air for City Apartments

Engineer Would Provide Uniform Climate Within Huge Enclosure—Claims Big Coal Saving

INSTEAD of subjecting the homes and apartment houses of our cities to the icy blasts of winter and the scorching heat of summer, why not build a vast enclosure over large numbers of them, creating within an artificial climate the year round? Such is the novel proposition of Samuel R. Lewis, author of a paper on "Group Heating of Buildings," presented at the Nov. 13 meeting of the Chicago chapter of the American Society of Heating and Ventilating Engineers. By providing a central heating and refrigerating plant for a great enclosure one-half mile square and 100 ft. high, it would be possible, said Mr. Lewis, to maintain within a uniform temperature of 70 deg. F. and to provide pure air, free from dust and soot, to the occupants.

In an enclosure measuring in plan 2,550x2,625 ft., Mr. Lewis proposed that 16,128 apartments be built, to house 65,000 people. The structure would be 100 ft. high from street to roof, with 75-ft. apartment space alternating with 75-ft. streets running north and south. The roof and the side walls forming the enclosure were to be insulated thoroughly and monitors were to cover the streets for their full length. The vertical or sloping surfaces of the monitors were to be made up of triple glass, hinged to allow for adjustment. Through this glass the apartment fronts would get the east or the west sun and artificial vegetation at the street level would be possible, particularly as artificial showers over localized sections of the enclosure were to be an everyday occurence to wash the air and assist in its circulation. At the center of the enclosure would be an east-and-west boulevard with double-vestibule entrance and exit.

Would Reduce Heat Loss

The heat loss for such a structure was estimated at 199 million B.t.u., which called for the equivalent of 796,000 sq.ft. of direct steam radiation. Thus the heating requirement per apartment reduced to the equivalent of 50 sq.ft. of radiation, as compared to the 250 sq.ft. ordinarily employed. Allowing 70 lb. of coal per square foot of radiation per season, this would mean a saving of approximately 112,000 tons of coal, which at $5 per ton would exceed in value one-half million dollars.

To offset the cost of the enclosing structure, amounting to $16,135,000, or about $1,000 per apartment, the temperate climate would permit cheaper construction in the buildings. Also, the vertical columns of the enclosure could be utilized to support the apartments.

As a commercial proposition the author considered such a plan feasible for the congested districts of large cities. For private homes, of which 2,208 could be placed in such an enclosure, the conditions were not so favorable. It was his prediction that the roofing over of streets in the business districts would come about early, as the saving in heat alone would warrant it.

Special Issue on Power Show and A.S.M.E. Meeting

Containing a complete account of those features of the A.S.M.E. annual meeting and the first National Exposition of Power and Mechanical Engineering that will be of the greatest interest to power-plant men, POWER for Dec. 12 will perform a big service for its readers. The issure will contain a special 32-page section devoted entirely to the show and meeting, and it will appear at the Power Show on Saturday morning, Dec. 9. Armed with POWER'S description of the Power Show, the visiting engineer or executive will be able to decide just what exhibits he wants most to see and thus may plan his time to the best advantage. And, as usual, there will be a running account of the A.S.M.E. sessions, with concise summaries of those papers and discussions touching upon the power field. In fact, the gist of everything that our readers want to know about the meeting and show will be found in this special issue.

Arkansas's First Hydro Plant Ready in March

The first unit of Arkansas's first large water-power project will be completed on Little Red River, near Judsonia, in March, 1923, if construction work moves along at its present rate. In a recent interview, Virgil Pettie, of Little Rock, president of the Arkansas Power Corporation, said: "The entire project is financed, a market for two-thirds of the power already arranged for, and we anticipate no interruption in our work. There is little doubt that the sections reached by our transmission lines will undergo a tremendous industrial growth."

A steam-power plant of 18,000 kw. initial and 50,000 kw. ultimate capacity is being built by the Williiamsport Power Co., of Hagerstown, Md., recently incorporated with capital stock of $250,000.

"May the Best Man Win!"

This Is Said To Be Alabama's Attitude Regarding Muscle Shoals—Henry Ford Favored at Present

THAT Alabama and the other interested Southern States favor giving Muscle Shoals to the organization that will develop the region to the greatest public advantage was the statement of A. G. Patterson, president of the Alabama Public Service Commission, as quoted in Detroit newspapers. Since Henry Ford's proposition has been the most attractive so far, according to his Congressional supporters, Alabama is in favor of his having Muscle Shoals, provided that he and Congress eventually agree, as Mr. Patterson believes they will. If anyone else, however, should make a more attractive offer than Ford for Muscle Shoals, that offer should be accepted.

Grants Right To Profit

The South does not believe Ford to be a philanthropist, Mr. Patterson continued, but thinks that he is looking, quite naturally, for profit from the venture. Nor does the South believe that Ford's offer should be accepted as last presented; but if Ford so modifies his offer that Congress can accept it, Mr. Patterson believes that, on account of the magnitude of the proposition and the benefit to be derived from it, the period of lease should be extended from fifty to a hundred years, such an exception to the usual practice being justified. The same exception, he said, might well apply to other projects, if necessary to promote needed development.

The printed record of the Muscle Shoals hearing conducted by the Senate committee on agriculture and forestry, during the last session of Congress, is being distributed. Accompanying the record is a letter signed by Senator George W. Norris of Nebraska, chairman of the committee, summarizing his arguments against the adoption of the development plans advocated by Henry Ford and his Congressional supporters.

Swedish "Atmos" Boiler Has Rotating Tubes

Extended tests of a new type of steam boiler known as the "atmos boiler" have just been completed at Gothenburg, Sweden, the inventor being Mr. Victor Blomqvist, a mechanical engineer of Stockholm. The basic principle is that the tubes, straight and of unusually large diameter, are kept constantly rotating at 330 r.p.m. about their longitudinal axes. This is said to force the steam bubbles instantly toward the center of the tube because

of the centrifugal action of the water. The walls of the tubes are thus constantly covered with a layer of water and there is the greatest possible transmission of heat. The tubes are rotated by a steam turbine or electric motor, driving through a gear train.

Steam Turbine Wrecked in Minnesota Plant

On Nov. 10, in the municipal plant of the City of Hibbing, Minn., a 1,500-kw. 60-cycle three-phase turbo-generator making 3,600 r.p.m. was badly wrecked. Nobody was hurt in the accident, although the building was damaged to some extent and the machine will have to be replaced. The plant has two other units, rated at 500 kw. each, so that partial service may be maintained. The contract for a duplicate turbine unit has already been awarded the Westinghouse Electric & Manufacturing Co.

The damaged unit had been in service for only a few months. At the time of the accident it was being brought up to speed to operate in parallel with the other machines. The cause of the trouble has not been determined definitely, but for one thing it is pretty generally understood that the safety stop had been blocked. At the present writing a thorough investigation is in progress, and *Power* hopes to have full details in an early issue.

May Burn Lignite for Power in Texas

Believing that the lignite found in vast quantities in Bastrop County, Tex., can be used for power generation, the Texas Power & Light Co. is investigating the problem of burning that fuel, according to W. B. Head, chairman of the board of directors. Government surveys show that Texas has more than one-half the lignite supply of this country and that the strata near Bastrop are of good quality and of almost unlimited extent. If the results of the investigation are favorable, the Texas Power & Light Co. will build a lignite-burning plant in Bastrop County, large enough to supply power for all the central Texas cities and towns in the company's territory.

To Install Final Unit at Calumet

The Commonwealth Edison Co. has ordered from the Westinghouse company for installation in its Calumet station one 37,000-kw. tandem compound turbine, direct-connected to a single 43,500-kva., 85 per cent power factor, three-phase, 60-cycle, 12,800-volt generator. The operating conditions for the turbine are 300 lb. steam pressure, 225 deg. superheat and 29 in. vacuum.

The turbine is of the Westinghouse parallel-flow type, the steam expansion being divided between two separate, tandem-coupled elements driving a single generator. The unit is the sixth ordered for this station and completes the installation as originally planned.

Navy Teaches Shipping Board How to Burn Oil

Having attained such good results in increased efficiency and decreased costs by close instruction of engine-room and fireroom personnel, the Navy Department has offered to share its facilities with the Shipping Board by inviting the latter to send its engineers to the fuel-oil testing plant at the Philadelphia Navy Yard. Nearly one thousand of the Board's engineers already have filed applications for the course. These men are being handled in relays of thirty to fifty each at the Philadelphia station, where they are given instruction for a week or two weeks, according to their previous experience. The course applies only to oil burning, instruction in firing with coal being a more simple matter and being given by the Navy only on shipboard or at active shore stations.

Although stressing economy and efficiency, the Navy Department has not relaxed its insistence upon full regard for safety precautions and in the competitions between firerooms and between watches care is taken that the spirit of rivalry does not reach the point where any chances will be taken in order to cut costs. One pump might be sufficient, for instance, and if everything went all right there would be a saving of steam, and hence of fuel, by not keeping a second pump working, but if anything went wrong there would be trouble, so the margin of safety is always maintained at the expense of a little fuel.

Coming Conventions

American Society of Mechanical Engineers, 29 West 39th St., New York City. Annual meeting at New York City, Dec. 4-7.

American Society of Refrigerating Engineers; W. H. Ross, secretary, 154 Nassau St., New York City. Annual meeting at New New York City, Dec. 4-6.

National Exposition of Power and Mechanical Engineering. Grand Central Palace, New York City, Dec. 7-13.

Kansas Engineering Society; T. M. Averill, secretary, Topeka, Kan. Annual meeting at Topeka, Dec. 14-15.

American Association for the Advancement of Science; L. O. Howard, secretary, Smithsonian Institution, Washington, D. C. Annual meeting at Boston, Dec. 26-30.

American Engineering Council; L. W. Wallace, secretary, 24 Jackson Place, Washington, D. C. Annual meeting at Washington, D. C., Jan. 11-12.

Marine Engineers' Beneficial Association; George A. Grubb, secretary, Machinists' Bldg., 9th St. and Mount Vernon Place, Washington, D. C. Annual meeting at Washington, Jan. 15-20.

Iowa Engineering Society; Lloyd A. Canfield, secretary, 406 Flynn Bldg., Des Moines. Annual meeting at Des Moines, Jan. 23-26.

American Society of Heating and Ventilating Engineers, 29 West 39th St., New York City. Annual meeting: Jan. 23 at New York City, Jan. 24-26 at Washington, D. C.

American Institute of Electrical Engineers, 29 West 39th St., New York City. Mid-winter convention at New York City, Feb. 14-16.

American Institute of Mining and Metallurgical Engineers, 29 West 39th St., New York City. Annual meeting at New York City, Feb. 19-21.

After long negotiations the entire property of the Toronto Power Co. was taken over on Nov. 1 by the Hydro-Electric Power Commission of Ontario, for the sum of $32,734,000. The following properties were involved: the Electrical Development Company of Ontario, with power house at Niagara Falls, Ont.; the Toronto Power Co., the Toronto & Niagara Power Co., the Toronto Electric Light Co., the Toronto & York Railway Co. and the Aurora & Schomberg Railway Co. The Toronto Power Co. will continue as a separate corporation with the following officers: Sir Adam Beck, president; Col D. Carmichael, vice-president; W. W. Pope, secretary; F. A. Gaby, director; J. W. Gilmour, treasurer.

The San Fernando steam power plant, of Los Angeles, Calif., has been formally opened by E. F. Scattergood, chief electrical engineer of the power and light bureau of the Public Service Department. The plant, costing approximately $500,000 and capable of developing 8,000 hp., is the fifth of a chain of power plants now operated by the city.

New Publications

Condensed Catalogs of Mechanical Equipment. Twelfth annual edition. Published by American Society of Mechanical Engineers, 29 West 39th St., New York City. Flexible "Atholeather" cover, 7x10 in.; 622 pages. Price $5 (free to standing members A.S.M.E. of year of publication).

This annual publication has been greatly improved by printing on the standard 7x10-in. type page, on thin paper, and by binding in a flexible cover. It consists of (1) a catalog section classified according to equipment; (2) a general classified directory of manufacturers in the mechanical field, cross-indexed, with names and addresses inserted free of charge, and (3) a directory of consulting engineers, classified according to their special fields of service.

The Welding Encyclopedia. Second edition. Edited by L. B. Mackenzie and H. S. Card. Published by The Welding Engineer Publishing Co., 608 S. Dearborn St., Chicago. Flexible imitation leather, 6x9 in., 314 pages text, 74-page catalog section and buyer's index. Price $5.

A reference book of the four autogenous welding processes — oxy-acetylene, electric arc, electric resistance and thermit—a chapter being devoted to each. A dictionary section of 150 pages defines the principal terms in welding nomenclature. Other chapters deal with boiler, tank, pipe and rail joint welding; rules and regulations, including the A.S.M.E boiler code (1918); heat treatment of steel; and flame and

temperature color charts are given. The present edition contains over fifty per cent more text than its predecessors.

Elements of Industrial Heating. Published by the W. S. Rockwell Co., 50 Church St., New York City. Paper; 8½ x 11 in.; 44 pages. Free.

This bulletin, No. 250, is a collection of the educational pamphlets on industrial heating that have been published from time to time by the Rockwell company. The authors—engineers of the company—emphasize strongly the general lack of knowledge concerning the application of heat to industrial processes, and the consequent need for "better methods of heating and handling, better equipment and, above all, men better qualified to apply properly in practice the simple principles of one of the oldest and most important, though indifferently practiced, industrial arts."

An unusually impartial review of the various types of heating furnaces is given, and there are innumerable small sketches of various types of furnaces—heat-treating, annealing, processing, regenerative, continuous and automatic. There are also charts on the influence of furnace design on cost of production, factors governing the selection of furnaces and of fuels, comparative fuel costs, etc.

The intention was to present a collection of material that might be used as a supplementary textbook for shop-training classes, vocational schools and colleges, and this intention has been well carried out. Since the book contains much information that has never before been published under one cover, it should prove valuable to every engineer whose work has to do with industrial heating in any of its phases.

Obituary

Joseph Gelshion, for thirty-five years a member of Brooklyn Association No. 41, N.A.S.E., and for twenty years its treasurer, died on Nov. 16 at the age of fifty-eight. Mr. Gelshion had been employed for the last twenty-seven years by the National Licorice Co., of Brooklyn, and as a mark of respect the entire plant was closed on the day following his death. He has served many times as a delegate to the N.A.S.E. national convention and to the conventions of the New York State Association and the Combined Associations of Greater New York. He was a member of Knights of Columbus, and leaves a host of friends and brothers in his profession.

Personals

Walter H. Harvey, formerly supervising inspector of the winding dept., Westinghouse Electric & Manufacturing Co., Newark, N. J., has joined the engineering department of the New York Telephone Co., New Jersey division, as power-plant inspector, with headquarters at Newark, N. J.

H. S. Demarest, of Greene, Tweed & Co., has returned from a trip to England, where he found business conditions excellent.

A reception and banquet at which **Prince Gelasio Caetani,** the new Ambassador of Italy to the United States, will be the guest of honor is being planned by the Federated American Engineering Societies. No information has been received as yet at the Italian Embassy as to the time of the new Ambassador's arrival, but it is believed that he will be in this country by the first of the year, in which case L. W. Wallace, executive secretary of the federation, hopes to arrange to have Prince Caetani as the guest of honor at the annual banquet of the American Engineering Council. If that is done, arrangements will be made so that all engineers who desire may attend.

Society Affairs

Rhode Island Section, A.S.M.E., will hear a paper on "Air Conditioning in the Textile and Paper Industries," by J. O. Ross, of the J. O. Ross Engineering Corp., New York City, at the society rooms on Dec. 5 at 8 p.m.

Philadelphia Section, A.S.M.E., will hear an address by M. E. Lewis, mechanical engineer, of the Babcock & Wilcox Co., New York, on "The Development of the Forced Draft, Chain-Grate Stoker," at the Engineers' Club on Nov. 28.

Pennsylvania State Association, N.A.S.E., adopted a new constitution at a meeting in Johnstown, Pa., on Nov. 11. This constitution was the outcome of a year of hard work on the part of Past President James D. Rostron, who, in 1921, at the National Convention, was authorized to continue the work begun by the original reorganization committee. At the Johnstown meeting temporary officers of the State Association were elected as follows: Jos. F. Mooney, president, Cambria Association No. 21; Bro. Cook, vice-president, Quaker City No. 1; J. N. Calvert, secretary, No. 18; E. J. Burke, treasurer, Tacony No. 9; William G. DuBois, conductor, No. 26, and Past President J. G. Lewis, doorkeeper, Sharon No. 6.

Business Items

The Standard Turbine Corp., Wellsville, N. Y., has appointed E. E. Maher as district sales manager in Chicago, with offices at 2237 Insurance Exchange Building. The Chicago office will handle business for the greater part of Indiana, Illinois and Iowa.

H. J. Marks & Co., Inc., 90 West St., New York City, the New York representatives of the Badenhausen boiler, have taken over the New York agency of the France Packing Co., of Tacony, Pa., manufacturers of metallic packing.

Harrisburg Foundry & Machine Works, Harrisburg, Pa., has appointed Frank F. Boyd as general sales manager and Albert E. Gastrock as assistant general sales manager.

The Compagnie Parisienne pour Distribution d'Electricite, Paris, France, has ordered Riley stokers for six new type W Stirling boilers. The stokers are to be the same size as those at Gennevilliers—18-retorts on each side, 36 retorts in all. These stokers will be made in France by the French company, Fama.

Trade Catalogs

Deaëration.—H. S. B. W. Cochrane Corp., Philadelphia, Pa. A 15-page booklet discussing the deaëration of water to prevent corrosion in piping, economizers and boilers. The Cochrane Vacuum Deaërating Heater is designed to deliver water free from dissolved oxygen at any temperature from 140 deg. F. up, as required for hot water heating and service systems and for feeding economizers and boilers. Charts are given showing the amount of iron converted into rust by water containing different amounts of oxygen. The Winkler test for detecting dissolved oxygen in water is also described.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Nov. 13, 1922	Nov. 20, 1922
Pool 1,	New York	$4.75-5.00	$4.50-5.50
Smokeless,	Columbus	6.00-6.50	6.00-6.25
Clearfield	Boston	3.00-3.75	3.50-4.25
Somerset,	Boston	3.25-4.25	3.75-4.50
Kanawha,	Columbus	4.00-4.50	3.50-3.75
Hocking,	Columbus	3.25-3.75	3.25-3.75
Pittsburgh No. 8	Cleveland	3.50	3.50-3.75
Franklin, Ill.,	Chicago	4.00-4.25	4.00-4.25
Central, Ill.,	Chicago	3.00-3.25	3.00-3.25
Ind. 4th Vein,	Chicago	3.75-4.00	3.75-4.00
West Ky.,	Louisville	2.35-2.75	2.25-2.75
Big Seam,	Birmingham	2.25-2.50	2.25-2.50
S. E. Ky.,	Louisville	4.00-4.50	3.75-4.25

FUEL OIL

New York—Nov. 23, Port Arthur light oil, 22@25 deg. Baumé, 4⅞c. per gal; 30@35 deg., 5¼c. per gal., f.o.b. Bayonne, N. J.

Chicago—Nov. 18, for 24@26 deg. Baumé, 90c. per bbl.; 32@36 deg., 2¾@3c. per gal. in tank car, f.o.b. Oklahoma refinery, or freight adjusted.

Philadelphia—Nov. 20, 26@28 deg. Baumé, Oklahoma, 97½c.@$1.05 per bbl.; 30@34 deg., Oklahoma (group 3). 2¾@3c. per gal.; 16@20 deg. Seaboard, $1.35@$1.40 per bbl.

St. Louis—Nov. 20, f.o.b. Oklahoma 24@26 deg. 95c. per bbl.; 26@28 deg. $1 per bbl.; 28@30 deg., $1.05 per bbl.; Gas oil 32@36 deg. 2¾@3c. per gal.; 36@40 deg. distillate, 3½@3¾c. per gal.

New Plant Construction

PROPOSED WORK

Ark., Springdale—The Welch Grape Juice Co., Westfield, N. Y., plans the construction of an individual power house in connection with its plant, here. Owner is in the market for equipment for same.

Calif., Berkeley—The city, E. M. Hann, Clk., will receive bids until Dec. 1 (change of date) for the installation of 151 electroliers, transformers and tops, with underground conduits, etc., in University Ave., between Grove and 2nd Sts. and in San Pablo Ave., from south city limits to north city limits. C. L. Huggins, City Engr. Noted Oct. 31.

Calif., Merced — The Merced Irrigation Dist., W. D. Wagner, Secy., will receive bids until Dec. 5 for furnishing F.O.B. factory 2 pumps direct connected to 2 electric motors with motor control equipment for Booster Plant No. 2 of Lake Yosmite-Le Grand highline canal, to discharge 12 cu.ft. of water per sec. and 5 cu.ft. water per sec. respectively against total head of 27 ft.; also 2 pumps direct connected to 2 electric motors with motor control equipment for Booster Plant No. 3, Lake Yosemite-Le Grand highline canal, to discharge 10½ cu. ft. of water per sec. and 4½ cu.ft. water per sec. respectively against total head of 20.3 ft., motors each to have rating of 440 volts, 60 cycles and 3 phase. R. C. Starr, Ch. Engr. of District.

Col., Denver—Blaney-Murphy Co., Stock Yards, is having plans prepared and will soon receive bids for the construction of a 5 story packing plant on 48th and Gilpin Sts. Estimated cost $750,000. L. B. Hill, Purch. Agt., will soon be in the market for machinery.

Ill., Chicago—The Chicago Metallic Mfg. Co., 542 West 35th St., is in the market for air compressors, hangers, shafting, pulleys and belting.

Ill., Shelbyville—The city is having plans prepared for an electric light and power plant and distribution system. $100,000 bonds voted for same. A. W. Fuller, 1979 Railway Exchange, St. Louis, Mo. Noted Oct. 24.

Kan., Hutchinson — The Walcott Hotel Co. will receive bids in December for the construction of an 8 story, 75 x 150 ft. hotel. Estimated cost $400,000. McKechnic & Trask, 719 Floyd Bldg., Kansas City, Archts. Equipment detail not reported. Noted Nov. 7.

Kan., Wichita—The Wichita Eagle, Market and Williams Sts., C. Speer, Purch. Agt., is in the market for water filter for steam boiler and a 90 hp. steam engine.

Mass., Boston — The city will receive bids about Dec. 1, for the construction of a high school on Dunbar Ave. Estimated cost $1,000,000. McLaughlin & Burr, 88 Tremont St., Archts. Equipment detail not reported. Noted Oct. 31.

Mich., Detroit — The Bd. Educ., 1354 Broadway Ave., received bids for the construction of a 2 story, 58 x 182 ft. and 67 x 181 ft. school, including steam heating system on Duboise and Waterloo Sts., from F. N. Cooper, 6370 Gratiot Ave., $321,104; A. W. Kutsche & Co., 535 Griswold St., $325,597, Corrick Bros., 507 Owen Bldg., $326,818; also for a 2 story, 171 x 191 ft. school on Palmer Ave., including steam heating plant, boiler and plenum system of ventilation, from Martin & Krausmann Co., 606 Vinton Bldg., $403,500, M. A. Mahoney, 400 Penobscot Bldg., $416,524, John Bollin Co., 2032 1st Nat'l. Bk. Bldg., $443,000. Malcolmson, Higginbotham, Palmer, 405 Moffat Bldg., Archts. Noted Sept. 26.

Mich., Monroe—The city, F. M. Kressoach, Clk., will receive bids until Dec. 11 for furnishing and installing pumping station equipment as follows: one million gal. per day steam pumping engine, 1 steam turbine driven electrical generator, two 150 hp. water tube boilers, 2 boiler feed pumps, 1 feed water heater, hand power traveling crane, 2 one million gal. per day and 1 two million gal. per day motor driven centrifugal pumps, sump pump, piping, etc. Hoad, Decker, Shoecraft & Drury, Ann Arbor, Engrs.

Mich., Petoskey—The Petoskey Portland Cement Co., is having preliminary plans prepared for additions to plant, power plant to be increased from 2,000 to 4,000 kw. Estimated cost $500,000. J. C. Buckley, 1st Natl. Bk. Bldg., Chicago, Engr.

Mich., Portland—The city, E. Jenkins, Supt., Municipal power plant, will receive bids until Dec. 11 for a 200 hp. oil engine, steel tank, 12,000 gal. capacity; also a 2,300 Volt 2 phase, 60 cycle direct connected generator.

Minn., Bemidji—The State Bd. of Control, D. F. Mullen, Secy., Capitol, St. Paul, plans additions to the State Teachers' College, here, as follows: 3 story addition to main building, $113,000; 3 story addition to dormitory, $95,000; heating plant, $65,000. C. H. Johnson, 715 Capital Bk. Bldg., St. Paul, Archt.

Minn., Chisholm — The Bd. Educ., J. P. Vaughn, School Supt., will receive bids until Dec. 15, for the construction of a 3 story, 198 x 395 ft. junior high school, including steam heating system. Estimated cost $500,000. German & Jensen, Exchange Bank Bldg., Duluth, Archts. Noted Oct. 3.

Miss., Lumberton—The Ashbrook Veneer Co., C. Ashbrook, Pres., is in the market for lumber and veneer mill equipment, including electric motors.

Miss., Magee—The city plans electric light plant and waterworks. Estimated cost $25,000. Swanson-McGraw, 705 United Fruit Bldg., New Orleans, La., Consult. Engrs.

Mo., Brookfield—The North Missouri Power Co., formerly the Brookfield Electric Light Co., plans extensive improvements, including installation of new machinery, a boiler with superheaters and chain stoke grates, etc. Estimated cost $150,000.

Mo., Joplin—The Lendreth Machinery Co., W. Landreth, Purch. Agt., is in the market for 3 to 12 hp. vertical boilers and air compressor 250 ft. capacity.

Mo., Maysville—C. L. Wright recently purchased the Maysville electric light plant and plans the construction of a new plant. Owner will be in the market for 3 oil engines. A. Sisson also plans the construction of an ice plant in connection with above plant.

Mo., Mountain Grove — The Mountain Grove Light, Creamery & Ice Co., is having plans prepared for the construction of a new plant to replace one recently destroyed by fire. Owner is also in the market for additional machinery for its plant at Carthage.

Mo., Poplar Bluff—The city will purchase a 500 hp. turbine eletcric generator. Estimated cost $20,000.

Mo., St. Louis — The Ford Motor Co., Highland Park, Mich., plans the construction of a 1 story, 300 x 1,500 ft. automobile factory on the Mississippi River, here. Estimated cost $5,000,000.

N. J., Gloucester City—The city plans the construction of new pumping station and filtration plant. Estimated cost $80,000, Remington & Vosburgh, 6th and Market Sts., Camden, Engrs.

N. J., Hammonton—The Littlefield Ice & Coal Co., plans to install refrigerating machines, stills and conveyors for ice plant and cold storage building.

N. J., Ocean City—V. B. Smith, Archt., Guarantee Trust Bldg., Atlantic City, is receiving bids for the construction of an 8 story, 150 x 347 ft. hotel on 112th St. and Boardwalk, here, for J. H. Slocum. Estimated cost $850,000. Equipment detail not reported.

N. Y., Auburn—Lockwood, Greene & Co., Engrs., 101 Park Ave., New York, will soon receive bids for the construction of new machine shop, weave shed and extensions to power plant and dyehouse for the Firth Carpet Co., 62 South Division St., Auburn. Estimated cost $140,000.

N. Y., Brooklyn — Adelphi College, St. James Pl., had plans prepared for the construction of a group of college buildings on Washington Ave. Estimated cost $1,250,000. McKim, Mead & White, 101 Park Ave., New York, Archts. and Engrs. Equipment detail not reported.

N. Y., Brooklyn — The Bd. Educ., 500 Park Ave., New York, plans the construction of P. S. 187, including steam heating system, on Delamere Pl. Estimated cost $500,000. C. B. J. Snyder, Flatbush Ave. Extension, Archt. and Engr.

N. Y., Buffalo—The Culliton Ice Cream Co., 172 Guilford St., is in the market for machinery for ice plant on Halbert St. and Jewett Ave.

N. Y., Buffalo—The Island Warehouse Co., Ganson St., plans the construction of a 10 story, 100 x 268 ft. flour mill on City Ship Canal. Estimated cost $500,000. Architect not announced. Owner is in the market for machinery and equipment.

N. Y., Floral Park—The Bd. of Trustees have retained C. E. Marshall, Civil Engr., Hempstead, to prepare plans, submit estimates and report on a waterworks system, including pumping plant and standpipe, for the village.

N. Y., Fredonia — The village, A. R. Moore, Clk., is in the market for new electric light transformer, to relieve the present units and make possible the extensions to system.

N. Y., Freeport—The Bd. Educ. will receive bids until Dec. 4 (change of date), for a high school on Pine St. Estimated cost $600,000. W. Adams, 15 West 38th St., New York, Archt. and Engr. Equipment detail not reported. Noted Oct. 31.

N. Y., Ithaca—New York Gas & Electric Corp., S. J. Magee, Pres., 123 South Cayuga St., plans election to vote $650,000 bonds for extensions and improvements to lines and plants.

N. Y., Jamestown — Hotel Jamestown, F. O. Anderson, Pres. Executive Com., c/o Empire Case Goods Co., 142 Foote Ave., plans the construction of a 9 story, 121 x 165 ft., hotel, including boiler room and steam heating system, on 3rd and Cherry Sts. Estimated cost $1,225,000. Architect not selected.

N. Y., Lackawanna — The Lackawanna Steel Co., plans the construction of various additions to present mills, also new rail and steel mills, furnaces and shops, on Hamburg Turnpike. Estimated cost $15,000,000. W. A. James, Ch. Engr.

N. Y., New York—The 95th Realty Corp., J. E. R. Carpenter, Pres., 598 Madison Ave., is having plans prepared for the construction of a 9 story, 100 x 100 ft. apartment building on 95th St. Estimated cost $800,000. J. E. R. Carpenter, Archt. and Engr. Equipment detail not reported.

N. Y., Parma—The Cooper Elec. Corp., Hilton, plans the construction of a complete electric light and power plant, here. Estimated cost $50,000.

N. Y., Rochester—The Rochester Gas & Elec. Corp., J. Haftnkamp, Supt., Clinton Ave., N., plans the construction of a complete new water gas plant, from 4,000,000 to 5,000,000 cu.ft. per day capacity, on the west side of the Genesee River.

N. Y., Sheepshead Bay—W. Mortensen, Archt., 209 West 76th St., New York, will receive bids until Dec. 1 for the construction of an ice plant on Avenue Z and East 17th St., here, for the Superior Ice Co., Inc., 50 East 42nd St., New York. Estimated cost $250,000. Equipment details not reported. Noted Oct. 3.

N. Y., Tonawanda—The Tonawanda Power Co., Sweeney Bldg., plans the construction of a power plant on Webster St. Estimated cost $150,000.

N. Y., Tupper Lake — The Bureau of Yards & Docks, Navy Dept., Wash., D. C., will soon receive new bids for the construction of U. S. Hospital, here as follows: Part 1—general construction of buildings exclusive of plumbing, heating and lighting, Part 2—plumbing inside of buildings, Part 3—inside heating and outside steam distribution, Part 4—inside electric lighting and outside electric distribution, Part 5—boiler house equipment. The above was previously advertised under the following: Specification Nos. 4710-4718-4719-4725. Noted Oct. 24.

N. C., Asheville—E. W. Grove plans the construction of a large commercial hotel on Haywood St. Estimated cost $1,000,000.

N. C., Whiteville—The town plans to install waterworks and electric light systems. Estimated cost $80,000.

Ohio, Ashland—The J. E. Mathews Produce Co., had plans prepared for the construction of a 3 story, 60 x 75 ft. cold storage building, including 15 ton ice making equipment. L. J. Goodrich, 207 East 4th St., Engr.

Ohio, Akron—The Akron Enterprise Co., C. A. Barbian, Pres., plans the construction of a 2 story theatre on South Main St. Estimated cost $850,000. C. W. and G. L. Rapp, 190 North State St., Chicago, Archts.

Ohio, Cleveland—The Ever-Ready Brake Lining Co., 305 St. Clair Ave., N.E.., had plans prepared for the construction of a 10 story, 60 x 150 ft. store and office building, including steam heating system. H. W. Grieme, 110 Engineers Bldg., Archt.

Ohio, Dayton—The Consolidated Builders' Co., Salem Ave., H. J. Osborn, Pres., is having plans prepared for the construction of an 11 story, 50 x 160 ft. hotel on First St. and Robert Blvd. Estimated cost $500,000. F. J. Hughes & Co., 406 U. B. Bldg., Archts. Equipment detail not reported.

Ohio, East Cleveland (Cleveland P. O.)—M. Lees, 2099 Lamberton Rd., is having plans prepared for the construction of a 4 story, 250 x 250 ft. apartment building, including steam heating system, on Euclid and Wymore Aves. Estimated cost $1,500,000. H. F. Janowitz, Permanent Bldg., Archt.

Ohio, Zanesville—Terrick, Howell & McHote, H. S. Terrick, Mgr., is in the market for new electrical equipment for coal mine at Crooksville.

Okla., Ardmore—The Consumers Light & Power Co., plans the construction of a 6,000 ton cold storage plant. Estimated cost $100,000.

Ore., Portland—C. E. Linde, 510 Artizans Bldg., is in the market for elevators, refrigerators, refrigerating machinery, vacuum cleaning and heating and ventilating systems, for large apartment houses.

Pa., Phila.—The Archdiocese of Philadelphia, 19th and Race Sts., plans the construction of a 3 story high school on 49th and Chestnut Sts. Estimated cost $500,000. Hoffman, Henon Co., Finance Bldg., Archts. Equipment detail not reported.

Pa., Phila.—The Bd. Educ., 19th and Chestnut Sts., will receive bids until Dec. 7 for the construction of a 3 story junior high school on Washington Lane and Musgrave St., estimated cost $750,000; also plans the construction of a 3 story administration building on Cherry St. and Parkway Blvd., estimated cost $1,000,000 and a 3 story 150 x 171 ft. Trade School on Spring Garden and Brandywine Sts., $750,000. Private plans. Equipment detail not reported.

Pa., Phila. — Duffy Bros., 3255 North Front St., J. M. Duffy, Purch. Agt., plans to install conveyors, steam cooking vats and refrigerator plant in new factory.

Pa., Phila.—The 15th St. Realty Co., 15th and Chestnut Sts., plans the construction of a 24 story, 106 x 207 ft. bank and office building. Estimated cost $5,000,000. Ritter & Shay, North American Bldg., Archts.

Pa., Phila.—J. T. Shriner, 36 North Delaware Ave., plans to install refrigerating plant and conveyors in new plant on Front St.

Pa., Phila.—The United Gas Improvement Co., Broad and Arch Sts., plans to install producers, boilers, loading and unloading machinery and conveying system, at its new plant. Noted Nov. 7.

Pa., State College—Pennsylvania State College will soon receive bids for the construction of a 2 and 3 story dormitory, here. Estimated cost $2,000,000. Day & Klauder, Franklin Bank Bldg., Phila., Archts. Equipment detail not reported.

S. C., Ridgeway—The Ryan Engineering Co., Arcade Bldg., Columbia, will receive bids until Dec. 4, for the construction of an electrical distribution system, 13,200 volt transmission line from here to Winnsboro including substations, water distribution system consisting of 8, 6 and 1½ in. pipe, valves, hydrants, etc., sanitary sewer system, two 8 in. wells, one 60,000 gal. tank mounted on 100 ft. tower and alternate bids on a 75,000 gal. tank mounted on 100 ft. tower, for the city. Estimated cost between $50,000 and $60,000.

Tenn., Nashville—The Nashville Ry. & Light Co., Watkins Bldg., E. C. Edgar, Gen. Mgr., plans additions and extensions to its light and railway system, consisting of new turbine generators, switchboards, stoker equipment to power plant, 5 substations, high voltage lines, etc. Estimated cost $500,000.

Tex., Dallas—The Dallas Railway Co., Interurban Bldg., R. Meriwether, Gen. Mgr., will soon receive bids for negative feeders at the Jackson St. sub-station. Estimated cost $18,455.

Tex., Dallas—G. Gonzeles, 1227 Lenwoy St., is having plans prepared for a 7 story apartment hotel on Masten and San Jacinto Sts. Estimated cost $500,000. J. O. Taft, Archt. Equipment detail not reported.

Tex., Ft. Worth—R. O. Dulaney, Ft. Ring Oil Co., is having plans prepared for the construction of a 10 story, 58 x 95 ft. medical arts and office building on 6th and Threckmerten Sts. Estimated cost $1,400,000. R. A. Nicholais, Ft. Worth Natl. Bk. Bldg., Archt.

Tex., Galveston—The state has authorized plans for the construction of a 2 story office, museum and library building and heating plant. Estimated cost $600,000. H. M. Green, North Texas Bldg., Dallas, Archt. Engineer not selected.

Tex., Houston—A. C. Finn, Archt., Foster Bldg., will soon receive bids for the construction of a hospital for the Geo. Herman Estate. Estimated cost, first unit $400,000, total $1,000,000. Equipment detail not reported.

Tex., Snyder—The Snyder Utilities Co., D. P. Yoker, Pres., plans to purchase a Diesel engine with direct connected alternator, of about 200 kw. capacity.

Utah, Salt Lake City—The Utah Power & Light Co., Kearns Bldg., is having plans prepared for hydro-electric plant to consist of 2 units, 10,500 hp. each, on the Bear River near Soda. The construction work will be done by the Phoenix Utility Co., a subsidiary of above company.

Wash., Newport — The Marshall Lake Power & Land Co., plans the development of 5,000 acres, including flume, dam 6 ft. high and 100 ft. long, at Marshall Lake. Estimated cost $200,000. Engineer not selected.

Wash., Seattle—St. Vincent's Home for the Aged, is having plans prepared for the construction of a 3 story, 276 x 294 ft. institutional building in 3 three units, on 35th SW and West Edmund Sts. Estimated cost $1,000,000. J. Graham, Smith Bldg., Archt. Equipment detail not reported.

W. Va., Shinnston—The Alley Glass Co., L. Alley, Pres., plans the construction of a glass plant, including a power house. Estimated cost $250,000. Architect not announced. Owner is in the market for machinery and equipment.

Wis., Green Bay—H. O. Wood, c/o Hotel Wisconsin, 172 3rd St., Milwaukee, is organizing company which plans the construction of a 9 story, 130 x 160 ft. hotel on Adams St. Estimated cost $800,000. Architect not selected.

Wis., Milwaukee—The Cedarburg Dairy Co., c/o H. Berns, 1586 Prospect Ave., is having plans prepared for the construction of a 1 story, 100 x 150 ft. dairy on 11th St. Estimated cost $75,000. H. J. Esser, 82 Wisconsin St., Archt. Modern dairy and refrigeration machinery, belting and shafting, etc., will be installed.

Wis., Shorewood (Milwaukee P. O.)—The village, T. B. Olsen, Clk., voted $75,000 bonds to install electric lighting system to replace present gas system. Engineer not selected.

B. C., Vancouver—The Marconi Wireless Telegraph Company of Canada, Ltd., 111 St. Sacrament St., has made application to the Dominion Government for license to erect and operate a continuous wave wireless telegraph station, capable of direct communication with Great Britain and Australia. Estimated cost $2,000,000. Also contemplate the erection of other stations at Montreal, Que., Toronto, Ont., and Winnipeg, Mont., estimated $1,000,000 each.

Ont., Arnprior—The Arnprior Creamery, E. McKinny, Purch. Agt., is in the market for cold storage plant, boiler, and manufacturing equipment.

Ont., Halleyburg—The town has retained F. Barber, 40 James St., Toronto, and associates, Engrs., to report on a comprehensive fire protection scheme, which will probably entail, new pumps, electric and possibly gasoline driven turbine fire pumps. Estimated cost $30,000.

Ont., Ottawa—Barret Bros., 260 Catherine St., are in the market for an 80 hp. boiler 14 ft. long.

Que., Montreal—J. Atter, 47 Chesterfield Ave., Westmount, is in the market for a 20 hp. coal oil engine.

CONTRACTS AWARDED

Calif., Fresno — The Pacific Southwest Trust & Savings Bank, awarded the contract for the construction of a 10 or 15 story office and bank building on Mariposa and J Sts., to the R. F. Felchlin Co., Bank of Italy Bldg. Estimated cost $1,000,000. Equipment detail not reported.

Calif., San Francisco—The Crosswings Community Apts., c/o H. H. Gutterson, Archt., 278 Post St., awarded the contract for the construction of a 9 story apartment building on Sacramento and Mason Sts., to the Clinton Constr. Co., 923 Folsom St., $1,000,000. Equipment detail not reported.

Ill., Chicago—G. K. Spoor, 908 Argyle St., awarded the contract for the construction of a 14 story, 90 x 137 ft. apartment building at 822 Argyle St., to Paschen Bros., 111 Washington St. Estimated cost $1,500,000. Steam heating system will be installed. Noted Nov. 14.

Ill., Marshall—The city awarded the contract for the construction of electric light and power plant, including equipment, to the Chuse Engine & Mfg. Co., 1411 Chemical Bldg., St. Louis, Mo., $65,989. Noted Oct. 24.

Mass., Boston—The Modern Realty Co., c/o A. Kanter, 1185 Commonwealth Ave., will build by day labor, a 6 story, 75 x 200 ft. apartment building. Estimated cost $500,000. Equipment detail not reported.

Me., Auburn—The Bd. of Water Comrs., awarded the contract for a 28 x 62 ft. electric pumping plant for the waterworks, to the Portland Constr. Co., 52 Exchange St., Portland, $16,500.

Mo., Moberly—The city council awarded the contract for 2 pumps, one 700 g.p.m. and one 1,200 g.p.m., electrically driven, and one 1,000 g.p.m. pump gasoline engine driven for waterworks, to the Benson Pump Co., Kansas City.

Neb., Omaha—The Bd. Educ., City Hall, awarded the contract for the construction of a 3 story, 174 x 369 ft. high school on 33rd St. and Ames Ave., to Peter Kiewitz's Sons, 754 Omaha Nat'l. Bk., $623,000. Heating and ventilating systems awarded to J. J. Haughen Co., 617 South 14th St. Noted Nov. 7.

N. J., Elizabeth—The Bd. Educ., A. P. Hughes, Secy., 537 Jefferson Ave., will build a high school on Westfield and Cherry Sts. Estimated cost $495,000. Kilham, Hopkins & Greeley, 9 Park St., Boston, Mass., Archt. Equipment detail not reported.

N. J., Hammonton—The Littlefield Ice Co., awarded the contract for the construction of a 3 story ice and storage plant, to W. F. Koller & Co., Otis Bldg., Phila., $50,000.

N. J., Plainfield—The Muhlenberg Hospital, Park Ave., awarded the contract for the construction of an addition to hospital, to L. V. Tallamy, 211 North Ave. Estimated cost $500,000. Equipment detail not reported. Noted Nov. 14.

N. Y., Brooklyn—The Methodist Episcopal Hospital, 6th St., awarded the contract for a 100 x 145 ft. addition to hospital on 6th St. and 7th Ave., to the Wm. Kennedy Constr. Co., 215 Montague St. Estimated cost $450,000. Steam heating system will be installed. Noted Sept. 19.

N. Y., New York—The Empire State Ice Co., 76 West Monroe St., Chicago, Ill., awarded the contract for the construction of a 3 story, 110 x 136 ft. ice making plant on 161st St. and Grant Ave., here, to Newenhous Company, Inc., Park Ave. & 161st St., New York. Estimated cost $135,000.

N. Y., New York—Hotel Roosevelt, c/o George B. Post Sons, Archts. and Engrs., 101 Park Ave., awarded the contract for the construction of an 18 story, 215 x 215 ft. hotel on Madison Ave. and 45th St., to the Thompson-Starrett Co., 49 Wall St. Estimated cost $600,000. Steam heating system will be installed. Noted Sept. 19.

Ohio, Chillicothe — The Quartermaster General's Office, War Dept., awarded the contract for the construction of a U. S. Veteran's Hospital including mechanical equipment, to G. A. Fuller & Co., Munsey Bldg., Wash., D. C. $1,497,000. Noted Oct. 17.

Ohio, Cleveland—The Medical Centre Co., c/o L. Abrams, 525 Engineers Bldg., awarded the contract for the construction of an 11 story, 110 x 165 ft. commercial office building at 1001 Huron Rd., to the Hearn Constr. Co., 46th St. and Euclid Ave. Estimated cost $600,000. Steam heating system will be installed.

Pa., Phila.—The American Ice Co., 6th and Race Sts., awarded the contract for the construction of an ice manufacturing plant on Duncannon and Marcher Sts., to Levering & Garrignes, 552 West 23rd St., New York. Noted Nov. 14.

Pa., Phila.—The Corn Exchange Bank, 1506 Chestnut St., awarded the contract for the construction of a 6 story, 39 x 108 ft. bank and office building at 1510 Chestnut St., to H. E. Baton, 1713 Sansom St., $520,000. Equipment detail not reported. Noted Oct. 3.

Wis., Fond du Lac—The Gurney Refrigerator Co., E. G. Vail, Pres., 64 South Brooks St., awarded the contract for the construction of a 3 story, 60 x 140 ft., refrigerator factory and power house, to the Hutter Constr. Co., 138 Western St. Estimated cost $60,000. F. J. Stepnoski, Archt. Owner is in the market for machinery for the manufacture of refrigerators and power machinery.

Wis., Milwaukee—The Wisconsin Ice & Coal Co., 216 West Water St., awarded the contract for the construction of a 1 story, 114 x 120 ft. ice manufacturing plant on 31st and Galena Sts., to R. L. Reisinger & Co., 464 Oakland Ave. Estimated cost $60,000. Owner is in the market for ice making machinery.